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ABSTRACT

For this study of the effects of different instructional strategies in computer-managed instruction (CMI), undergraduates in a 10-week health education course were assigned to either a control group or to one of three CMI treatments: a remedial prescription-forced mastery group, a remedial precription-forced progression group, and a forced progression group. After the administration of a pretest and other evaluating measures, CMI students proceeded with their off-line study of each module of the course while the control group attended lectures and discussion groups. CMI students took a posttest at the computer terminal and were given further directions based on the results of this posttest coupled with the strategy assigned to their treatment group. Final test results indicated that the forced mastery group did best, although all CMI groups did better than the control group on the final examination, and that there were no significant differences in study time or number of days used to complete the module posttests among the CMI groups. In addition, results suggested that the learning strategies used by students were influenced by the course content or the instructional method or both. (Author/SH)

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TECH REPORT

AN INVESTIGATION OF SELECTED INSTRUCTIONAL STRATEGIES IN AN UNDERGRADUATE COMPUTER-MANAGED INSTRUCTION COURSE

R. Michael Lawler

Tech Report No. 19
April 30, 1971

Project NR 154-280
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In terms of content, one can anticipate a detailed discussion of the rationale of the research project, its design, a complete report of all empirical results as well as appendices that describe in detail the CAI learning materials utilized. It is hoped that by providing this voluminous information other investigators in the CAI field will have an opportunity to carefully consider the outcomes as well as have sufficient information for research replication if desired. Any comments to the authors can be forwarded via the Florida State University CAI Center.

Duncan N. Hansen
Director

Computer Assisted Instruction Center

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This study investigated the differential effects of selected instructional strategies in a computer-managed instruction (CMI) learning environment. The investigatory questions were primarily concerned with treatment group comparisons on measures of performance, attitude, and time. Questionnaires and other self-report measures were used to characterize student strategies.

The sample consisted of 167 undergraduates in a health education course at Florida State University. Forty-one of these students received traditional classroom instruction (CI group) and served as a control group. The remaining students were randomly assigned to one of three CMI treatments. For these latter students, the course was divided into 14 modules with a total of 32 objectives. Throughout the course, module posttests were

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administered which consisted of 5 items per objective which were randomly selected from a pool of 15 items. The criterion for passing a module test was set at 80%.

During the first week of classes the pretest and other evaluative instruments were administered to all students. For the remainder of the quarter, the CMI students proceeded with their study of appropriate self-instructional materials. When a student felt prepared to be tested, he scheduled computer time and was administered the posttest on the module he had completed. Upon course completion, the evaluative instruments and final examination were administered to all students. The final examination was composed of 4 items for each course objective. Half of these items were used in the module posttests, the other half were used only on the pretest and final examination.

One of the CMI treatment groups, Remedial Prescription-Forced Mastery, represented the most typical CMI strategy. If students in this group failed to reach criterion on an objective, they were presented remedial prescriptions and were required to take another randomly chosen set of items until they reached criterion.

Students in the Remedial Prescription-Forced Progression group who failed to reach criterion on an objective were only presented the remedial prescriptions and were not permitted to repeat the failed posttest.

In the Forced Progression group, students who failed to reach criterion on an objective were given neither remedial prescriptions nor were they permitted to repeat the failed posttest.

The results demonstrated a general superiority of the CMI groups over the CI groups on final examination performance. This superiority was attributed to (a) a greater degree of familiarity with the objectives and criteria for the CMI groups; (b) differential content emphasis; (c) the positive effects of frequent testing; (d) the composition of the final examination; and (e) possible differences in levels of achievement motivation on the final examination.

The results of performance and attitude measures failed to demonstrate the efficacy of requiring forced mastery only or of providing remedial prescriptions only. However, the group required to reach mastery, which was also given remedial prescriptions, had significantly greater mean final examination scores than the group which was not required to reach mastery nor given prescriptions. These data supported the interpretation that with this initial field test of the course, the effects of content organization, presentation format, and frequent testing overshadowed the more subtle effects associated with the differential CMI treatment characteristics.

ABSTRACT-continued

Comparisons of time indices among the CMI groups indicated no significant differences in study time or in the number of days required to complete half or all of the module posttests. Limited evidence suggested that the Remedial Prescription-Forced Progression group required significantly less computer time. Average time on the computer for all CMI students was approximately 3.5 hours, while CI students spent 30 hours in the classroom.

Finally, self-report measures and ancedotal remarks suggested that: (a) some students disliked the forced mastery requirement; (b) student "studying" strategies were influenced by the course content and instructional method; and (c) students of different strategy "types" performed differentially on the final examination.

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AN INVESTIGATION OF SELECTED INSTRUCTIONAL STRATEGIES IN AN UNDERGRADUATE COMPUTER-MANAGED INSTRUCTION COURSE

R. Michael Lawler

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This study investigated the differential effects of selected instructional strategies in a computer-managed instruction (CMI) learning environment. The investigatory questions were primarily concerned with treatment group comparisons on measures of performance, attitude, and time. Questionnaires and other self-report measures were used to characterize student strategies.

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During the first week of classes the pretest and other evaluative instruments were administered to all students. For the remainder of the quarter, the CMI students proceeded with their study of appropriate self-instructional materials. When a student felt prepared to be tested, he scheduled computer time and was administered the posttest on the

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Finally, self-report measures and ancedotal remarks suggested that: (a) some students disliked the forced mastery requirement; (b) student "studying" strategies were influenced by the course content and instructional method; and (c) students of different strategy "types" performed differentially on the final examination.

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CHAPTER I

INTRODUCTION

Background and Problem

The first computer was put on the commercial market in 1950. Now, just twenty years later, the computer has become a familiar part of the equipment of business and government. The appearance of the computer on the educational scene has been somewhat slower, although the numbers of computers used for educational purposes are multiplying at a rapid rate, especially on college campuses. According to the American Council on Education, 600 colleges and universities had computers in 1966. This number increased to some 1,100 in 1970. Information available from the Association for Educational Data Systems shows 800 school districts with computers in 1966. By 1970, the number of such school districts had nearly doubled.

More dramatic than the growth in numbers of computers is the growth in the ways in which computers are being used to help solve the problems of education. Computers have been used to various degrees in education for instruction, guidance, monitoring, managing, counselling, and general record handling. The first of these functions, instruction, is given the familiar acronym "CAI," Computer-Assisted Instruction. In this mode the computer assumes the primary instructional responsibilities and as such has been shown to be both effective and relatively expensive.

The latter five functions are generally subsumed under the title "Computer-Managed Instruction (CMI)." Within the CMI paradigm, the computer serves as diagnostician and prescriber of instruction; the emphasis being on mediation rather than the dissemination of instruction.

The feasibility of this relatively new utilization of the computer in education has been explored at System Development Corporation (Coulson, 1967), New York Institute of Technology (Schure, 1967), American Institutes for Research (Flanagan, 1968), and Florida State University (Hagerty, 1970). The appeal of CMI to these investigators lies in its adherence to a "systems approach" in software development and in the potential of the computer to manage a very large individualized course or total instructional program. Heretofore, this management dimension has taken various forms. Typically in the CMI paradigm, students are required to attain proficiency on each unit or module of instruction before being permitted to continue to the next. In such instances proficiency is operationally defined as correctly responding to a predetermined number of criterion-referenced test items, e.g., eighty percent. If a student fails to reach criterion, he is given some type of feedback in the form of remedial prescriptions keyed to those items missed on the criterion test. The student is then given the opportunity to complete the remedial exercises recommended by the prescription, and is required to return to demonstrate proficiency on the same moduel.

While these procedures appear pedagogically sound, several questions arise with respect to the comparative effectiveness of this strategy in light of some reasonable alternatives. These questions are likely to be asked by the designer of instructional systems, administrators, teachers, and students. Some of the more important questions which seem readily apparent are as follows:

1. Might it not be equally effective to permit responsible students to proceed at their own rate regardless of the initial ability to achieve criterion performance on each module presented via CMI?
2. To what extent are remedial prescriptions facilitative in a CMI framework?
3. Do students employ different strategies when mastery on each objective is required as opposed to not requiring mastery?
4. Do students employ different strategies when provided with remedialprescriptions as opposed to not providing such prescriptions?
5. Is there a general facilitative effect of CMI which can be attributed to frequent testing?

The present investigation critically examined these and other questions in an attempt to produce feasible answers. A more succinct description of these questions is contained in the Methods and Procedures chapter. Generally, several management strategies were evaluated by means of four treatment groups within a course in undergraduate Health Education presented via CMI. This evaluation considered: (a) within course performance; (b) final exam performance; (c) time spent on course related activities; (d) time to midterm and course completion under self-pacing conditions; (e) attitudes towards CMI; (f) attitudes towards health education; (g) module-specific confidence; and (h) some self report descriptors of student strategies, including motivation and expectancy.

Significance of the Problem

The use of computers and the individualization of the instructional process are becoming increasingly important factors at all levels of public education. The Florida State University Model for the Preparation of Elementary School Teachers (Dodl, 1969) recognizes that students vary significantly in their interests, levels of commitment, effective learning rates, preferred learning methods, and individual career goals. Further, the Model considers an individualized approach to teacher training as one way to optimize the learning process in light of this range in student variability.

This investigation was predictated on two fundamental premises alluded to above: First, that the individualization of instruction at all levels of public education is a desirable educational goal; and second, that CMI offers one effective and efficient means to manage a large individualized course. Specifically, this study focused on a host of problems associated with the use of alternative strategies in a CMI paradigm. The remainder of this section addresses itself to the principle CMI problem areas under consideration.

Although CMI is still in its infancy, the practices of providing remedial prescription and of requiring mastery at the objective or module level before progression may occur have been rather firmly established. Heretofore, these practices have not been critically examined.

There are several reasons why the above procedures may not be optimal from an instructional point of view. First, if a hierarchical dependency between objectives does not exist, one would not expect mastery of one objective to facilitate mastery on any other. Further, it remains to be demonstrated that mastery of an objective within a course facilitates performance on that objective at a later time, e.g., on a final examination. Secondly, is the time and effort expended in the development of remedial exercises warranted? Knowledge of incorrect responses may in itself provide enough information and motivation to the student to remediate his deficiences. Finally, such procedures may not be truly optimal if they promote undesirable attitudes towards CMI in general and the subject matter in particular.

It is posited that this investigation provides needed information regarding several alternative management strategies within a CMI paradigm. Certainly the strategies which delineate the respective treatment groups do not exhaust the list of conceivable alternatives. It is suggested that this study constitutes a significant contribution to the growing body of knowledge in CMI related activities.

CHAPTER II

REVIEW OF RELATED RESEARCH

In order to understand the context of the present investigation, this review presents some current conceptualization of CMI, and then provides a review of the investigations of CMI. It concludes with a brief summary of the research related to the experimental treatments under consideration.

Conceptualizations of CMI

Although various investigators have offered somewhat differing descriptions of CMI, there is a consensus of opinion that CMI is inextricably involved with the individualization of instruction Specifically, CMI is viewed as a methodology for realizing the potential of the computer in individualizing the educational process.

Glaser (1969) offers a general instructional model which he presents as a sequence of six operations, all of which could be subsumed under the heading, "individualized instruction." Though this general model can be implemented along a continuum of various degrees of automation, it is suggested that "automation can be a significant aid to the conduct of an individualized system and to the collection of research data so that the system can be improved (Cooley & Glaser, 1969)." For these authors then, CMI is conceptualized as a means of implementing those operations which characterize an individualized instructional model.

Still within an individualized framework, Jerman (1970) offers a slightly different formulation from that discussed above. This formulation regards CMI--computer mediated instruction--as being closely related to the concept of multimedia instruction. The most important distinction between the two concepts is that in computer-mediated instruction, the sequence of topics must be under computer control, even when the student is off-line. The function of this system as visualized by Jerman is to (1) introduce a topic; (2) test; (3) prescribe appropriate off-line materials for study; (4) review the off-line material; (5) retest; (6) report to the teacher; and (7) introduce a new topic, etc.

Perhaps the most inclusive conceptualizations regarding CMI have been formulated by co-investigators at Florida State University. Dick (1969) describes CMI as:

> The overall management of learning materials and evaluation of the students who are participating in a training program where the instruction is not primarily conducted by the computer, but through the use of other types of self-instructional materials.

Hansen (1970) includes the major educational functions of (1) information retrieval; (2) scientific computing; and (3) computer support of instruction within the broader concept of an information management system. The last of these major functions, viz., computer support of instruction, encompases CMI, computer-assisted instruction (CAI), and learning simulations. Further, it is Hansen's contention that CMI offers the most cost effective model as well as the greatest potential for subsuming the other two types, i.e., CAI and learning simulations (Hagerty, 1970).

The most significant aspect of FSU's approach to CMI is that the majority of the diagnostic evaluations and remedial prescriptions occur within a computer terminal-oriented interaction between the student and the CMI system. This technique insures real-time information exchange between the student and the system as well as immediately providing the student with his next learning assignment. Thus, the interactive terminal is the vehicle by which the individualization process under CMI is implemented.

The conceptual framework for the present investigation has been most strongly influenced by the work of Dick at Florida State University. As with Cooley and Glaser, the concept of individualization is central to this framework. In the present investigation, however, the use of the computer terminal to operationalize this individualized concept stems directly from previous research at Florida State. Finally, Jerman's (1970) distinction between "multimedia" and "computer mediated" are rather inconsequential. Though the functions of the presently envisioned CMI system closely resemble those suggested by Jerman, it is presently asserted that a CMI system can perform these functions equally well by having the instructional sequence student determined rather than computer assigned. Empirical support for this assertion is offered in a CMI investigation by Gallagher (1970).

CMI Investigations

In a recent review of computerized management systems for individualizing instruction, Hobson (1970) points out the following:

> (1) The current state of the art of developing these systems is in its infancy; (2) a total of four prototype systems have been developed and partially documented; (3) in the design of these four prototypes a batch processing mode of operation had been used extensively; and (4) each prototypic design was based primarily upon statements of their rationale with little or no data upon which to build an empirical model for the intended purpose.

One of the prototypic systems to which Hobson referred is titled, "The Instructional Management System (IMS)." The development of IMS was a cooperative effort between System Development Corporation (SDC) and the Southwest Regional Laboratory (SWRL). This system is presently operating in several Los Angeles City School Districts. IMS was designed to collect data and provide teachers with information upon which to base more effective instructional decisions (Kooi & Coulson, 1967; Coulson, 1967; Silberman, 1968; Kooi, 1968).

A second computerized management system for individualizing instruction is the Automated Instructional Management System (AIMS), undertaken by the New York Institute of Technology (Schure, 1967; O'Dierno, 1968). The design philosophy of the AIMS prototype emphasizes flexibility and modularity while permitting a wide range of data processing. Assessment data are currently being collected in the areas of mathematics, physics, computer science, and electronic technology.

The third prototypic system was developed at the Learning Research and Development Center, University of Pittsburgh. This sytem is given the acronym IPI/MIS which stands for Individually Prescribed Instruction/ Management and Information System. This model was designed to implement and evaluate IPI with a computer system. The IPI system had been in operation without computer support at Pittsburgh's Oakleaf School for some three years prior to the implementation via computer (Cooley & Glaser, 1969; Bolvin & Lindvall, 1968).

The fourth prototype--Program for Learning in Accordance with Needs (Project PLAN)--was recently described by Flanagan (1968). Project PLAN is being developed by the American Institutes for Research, Westinghouse Learning Corporation, and fourteen cooperating school systems. Much like SDC's prototype, this system is designed to collect objective-related test data to facilitate educational decision making. The PLAN system is currently serving approximately 9000 students at the elementary and secondary level.

Each of the foregoing CMI systems has the potential for branching, providing diagnostic evaluations and remedial prescriptions, and for exchanging the data base upon which educators can make more informed decisions (Brudner, 1969). Further, it should be noted that the four systems described above are in various stages of development and, as noted previously by Hobson, are only partially documented.

Before concluding this section of the review, three additional investigations at Florida State University will be briefly discussed. The first of these involved the design, development, and prototype implementation of a CMI system as a subcomponent of the Florida State University's proposed model for training elementary teachers (Hobson, 1970). As a result of this effort Hobson (1970) concluded that (1) a CMI system is technically feasible for approximately 1,000 trainees; (2) the volume of data generated by such a model requires a computer for data processing, trainee scheduling, testing, and overall program management; and (3) that technical difficulties associated with the development and implementation of such a system appear to be minimal.

The second FSU investigation dealt with the development and implementation of a graduate level course via CMI. This course, Techniques of Programmed Instruction, was implemented via CMI in the Fall of 1969 with an enrollment of 59 graduate students. An important feature of this approach was the student-terminal interaction which has previously been described. The components of the CMI logic included diagnostic testing, remediation, record keeping and data collection. No direct instruction was presented by the terminal; a printed study guide directed the students to textbooks and other printed materials (Hagerty, 1970). This particular study merits special attention in that the basic format used in materials development for the present investigation most closely approximates that used by Hagerty. A more detailed account of the materials development is included in Chapter III.

The third and final FSU effort dealt with an investigation of learner charactristics and instructional treatments in a CMI learning environment (Gallagher, 1970). This investigation was conducted jointly with that of Hagerty. The treatment groups in this study differed in terms of sequence of tasks (student selected or computer assigned) and type of evaluation (by instructor or student-computer interaction). Results of this investigation indicated no significant treatment group differences on any of four dependent measures: (1) midterm score; (2) final product score; (3) time to course completion; and (4) time on computer system. Further, using a series of multiple regression analyses, it was concluded that students who demonstrated superior performance could be characterized as persons who were not anxious, liked to be active in the learning situation, and were generally enthusiastic about the CMI presentation.

The preceding review clearly substantiates Hobson's (1970) contention that the state of the art in developing CMI systems is still in its infancy. The largest percentage of reported CMI research deals primarily with the documentation of the feasibility of both the development and implementation of such systems. Exceptions to this generalization are the conceptual formulations offered by Dick (1969) and Hansen (1970) and the experimental manipulation reported by Gallagher (1970) at Florida State University. However, though the development of CMI systems is still in its infancy, there is ample evidence that CMI is economically defensible and pedagogically sound. This assertion is a fundamental premise upon which this investigation was based. Specifically, it was asserted that more empirical research is needed within the context of CMI--research such as that presently undertaken.

Research Related to Proposed Experimental Variables

Thus far, this review has offered some current conceptualizations of CMI and briefly outlined the extant research in the area. In concluding the review of related research, an effort will be made to further clarify the proposed treatment conditions. Laying aside for the moment the CMI vs. traditional class comparisons, the principle variables of interest in this study were "mastery" and "remedial exercises."

Mastery

A common strategy in CMI may be characterized as follows: If the student meets criteria on the set of exercises in the introductory lesson, he proceeds directly to the next lesson. If he fails to meet the criterion on any subset of exercises, the student is directed to appropriate off-line sources of information. When the off-line material has been studied, the student returns to the terminal and retakes the criterion test. The implicit assumption in this procedure is that it is advantageous to have students satsify the minimal criteria before proceeding to another topic. The literature is replete with arguments in favor of such a procedure, especially when there is evidence for some hierarchical relationship among component topics or tasks (Gagné, 1965; Gagné, Mayor, Garstens, & Paradise, 1962). Ausubel (1963) hypothesizes that mastery of previous parts of a hierarchical task promotes facilitation in learning subsequent parts. In an effort to conceptualize this hypothesis, Ausubel (1967) introduces the constructs of "consolidation" and "integrative reconcilliation."

Further support for requiring mastery has been offered by Short, Geear, Haughey, & Tein (1968). In the final report of a project to develop a fundamental training course for AT&T, these authors discuss the important consequences of accepting mastery as the legitimate goal of training. Among the desirable consequences suggested is enhanced student-role perception. The student actively practices approximations of the mastery behavior, he can frequently evaluate his progress, and he is constantly rewarded because he meets mastery criteria.

Using a complex imaginary science called the Science of Xenograde Systems, Merrill (1964, 1965) obtained results which contradicted the hypothesis that learning and retention of a hierarchical task are facilitated by mastery each successive part of the material before proceeding to the next. Merrill (1964) concludes that "in a hierarchical task like Xenograde Systems, such a procedure is not essential to learning and is even detrimental in terms of efficiency rather than advantageous."

Remedial Prescriptions

Continuing the common CMI strategy outlined above, we find the student returning to the terminal to retake the criterion test if he has failed in his first attempt. If the student fails to meet the predefined level of criterion performance, he is given feedback (prescriptions) regarding sources of information designed to remediate his deficiencies. This procedure involves a second assumption regarding instructional effectiveness, i.e., if the student fails to meet criteria on a module posttest, one can facilitate learning by providing the student with additional information concerning sources considered valuable in remediating his difficulty.

Empirical support for the above contention is noticeably absent from the literature. It could be argued that support for this line of reasoning might be obtained from the feedback-knowledge of results literature. However, this body of research appears related to the basic question only tangentially, if at all. Further, it is asserted that each of the treatment groups proposed in this study (see Methods and Procedures) will be given feedback on each of the module posttests. To be sure, the quality of the feedback varies (prescription or correct answers only), but the notion of remedial prescriptions appears to constitute more than simple knowledge of results.

Summary of Previous Research and Investigatory Questions

The foregoing review substantiates the apparent need for an empirical investigation of the efficacy of (1) requiring mastery before progression may occur; and (2) providing remedial exercises for students failing to meet criteria on objective or module posttests in a CMI context. Of particular interest is the lack of research in the area of management strategies in CMI and the relationship of these strategies to student strategies, reported attitudes, and performance.

The specific questions which this CMI investigation attempted to answer are as follows:

1. Would the content organization, presentation format, and frequent testing of the CMI treatment groups facilitate final examination performance as compared to the classroom instruction group?
2. Would the requirement for reaching criterion performance on each module posttest facilitate within-course and final examination performance?
3. To what extent did the presentation of remedial prescriptions facilitate final examination performance?
4. Under which of four instructional treatments will students have the most positive attitudes?
5. Would treatment group assignment differentially affect the time that CMI students spent in: a) studying; b) completing half (7) and all (14) of the module posttests; and c) online testing?
6. What is the relationship between the students' self-reports of confidence and study time and their scores on the 14 module posttests?
7. What are the characteristics of students in terms of grade expectancy, motivation, and frequency and types of personal interactions; and are these characteristics differentially affected by treatment group assignment?

8. Are the general "study-strategies" employed by students altered by the course, in general, and by their treatment group assignment, in particular?

A variety of evaluative instruments and self-report measures were used in an effort to answer the foregoing questions. Brief descriptions of these instruments are given in the next chapter.

CHAPTER III

METHODS AND PROCEDURES

This chapter begins with a brief description of the principle components of the materials development process. These principle components are: a) course content; b) instructional modules, and c) remedial prescriptions. Second, the evaluation instruments are described. These are: a) the test items; b) attitude measures; c) time measures; and d) three additional instruments collectively referred to as "additional measures." The third and fourth topics are brief descriptions of the apparatus and the sample, respectively. The chapter concludes with a detailed description of the procedures and the experimental design.

Materials Development

A. Course Content

Health Education 319--The Health Program in the Elementary School, is an undergraduage course required of all elementary education majors at Florida State University. For the Fall Quarter of 1970, the course content was divided into 14 modules with a total of 32 objectives. A list of these modules and the number of objectives in each is attached (see Appendix A).

The course content embodied in these 14 modules was representative of the standard undergraduate health education curriculum. This fact is attested to by an examination of any representative sample of health education textbooks. This approach was rigidly adhered to in the development of the instructional modules. In addition, Dr. Marion Riser, Associate Professor of Health Education for some 20 years, granted final approval on all decisions regarding course content and test items.

Some of the objectives in Health Education 319 were related to the teacher's direct instructional responsibilities, i.e., content he would be expected to teach elementary school children. Examples of such content are: (a) nutrition; (b) drug information; (c) family life and sex education; (d) community health; and (e) first aid.

Other course objectives were related to the teacher's supra-instructional responsibilities. These objectives dealt with those teacher activities not directly related to instruction. Examples of this type included (a) the testing of vision and hearing; (b) observation of pupils physical appearance and abnormal behavior; (c) referral procedures; and (d) the maintenance and use of health records.

B. Module Description

Each of the objectives included in the course was presented within the framework of an instructional module. Each of the 14 modules contained the following components: (a) one to three performance objectives; (b) a sample test question for each objective; (c) a list of references for each objective; (d) resource materials appropriate to the achievement of the objectives; (e) a 5-item posttest for each objective; and (f) remedial prescriptions keyed to each of the objectives.

Components a, b, and c above were given to the students in a phamphlet entitled "HEE 319 Student Guide." Component d was provided to the students in the form of a compendium of recent articles, as well as readings from their textbooks. Components e and f, the module posttests and remedial prescriptions, were presented to CMI students via the IBM 1500 system.

C. Remedial Prescriptions

The remedial prescriptions are herein defined as written directions for a corrective procedure. Specifically, the corrective procedure entailed the re-examination of that resource material keyed to the failed objective. These written directions presented on-line usually referred the student to the exact location of the appropriate subject matter. In addition, these prescriptions were designed to either aid in the clarification of the objective or focus the student's attention on a critical feature of the resource material. An exemplary remedial prescription is shown below:

> You failed t meet the passing criterion of 80% on objective 2. It is strongly recommended that you:
>
> 1. Reread the objective carefully
> 2. Reread: New Physician, Aug., 1970, p. 651.
> 3. Reread: J. School Health, Feb., 68, pp. 68, 69.
> 4. Reread: Schifferes, Chapter 14. Note especially male and female anatomical features and ovulation in the female.
>
> *When you feel that you are prepared to retake this module posttest, you should reschedule terminal time at the CAI Center.

---

*Remedial Prescription, Forced Mastery Group Only.

Evaluation Instruments

A. Performance Measures

Test items used in performance assessment (pretest-final exam, and module posttests) were developed on the basis of the instructional objectives in each module. (There were a total of 32 objectives for the entire course.) Each item was approved by the content expert prior to its final acceptance. Five forms (a-e) of the pretest-final examination were developed. Each test form contained four items from each objective; two of which were common to all forms and two of which were unique to the respective test form. This procedure is schematically represented in Figure 1. This test development process resulted in: (1) a pool of 10 items stored in the computer for each objective, five of which were randomly selected and presented to the CMI students during the within-course testing; and (2) five alternate forms of the pretest-final examination with 64 items unique to each test form and 64 additional items common to all test forms.

The rationale for the procedure outlined above was twofold: First, item statistics were obtained for all test items and used in the course revision process; and second, comparisons between the common item and computer item portions of the final examination permitted a test of the generalizability of that content which was specifically tested during the course.

Final course grades for the Classroom Instruction group were determined by scores on three tests taken during the quarter (these students were also required to take the final examination). Final course

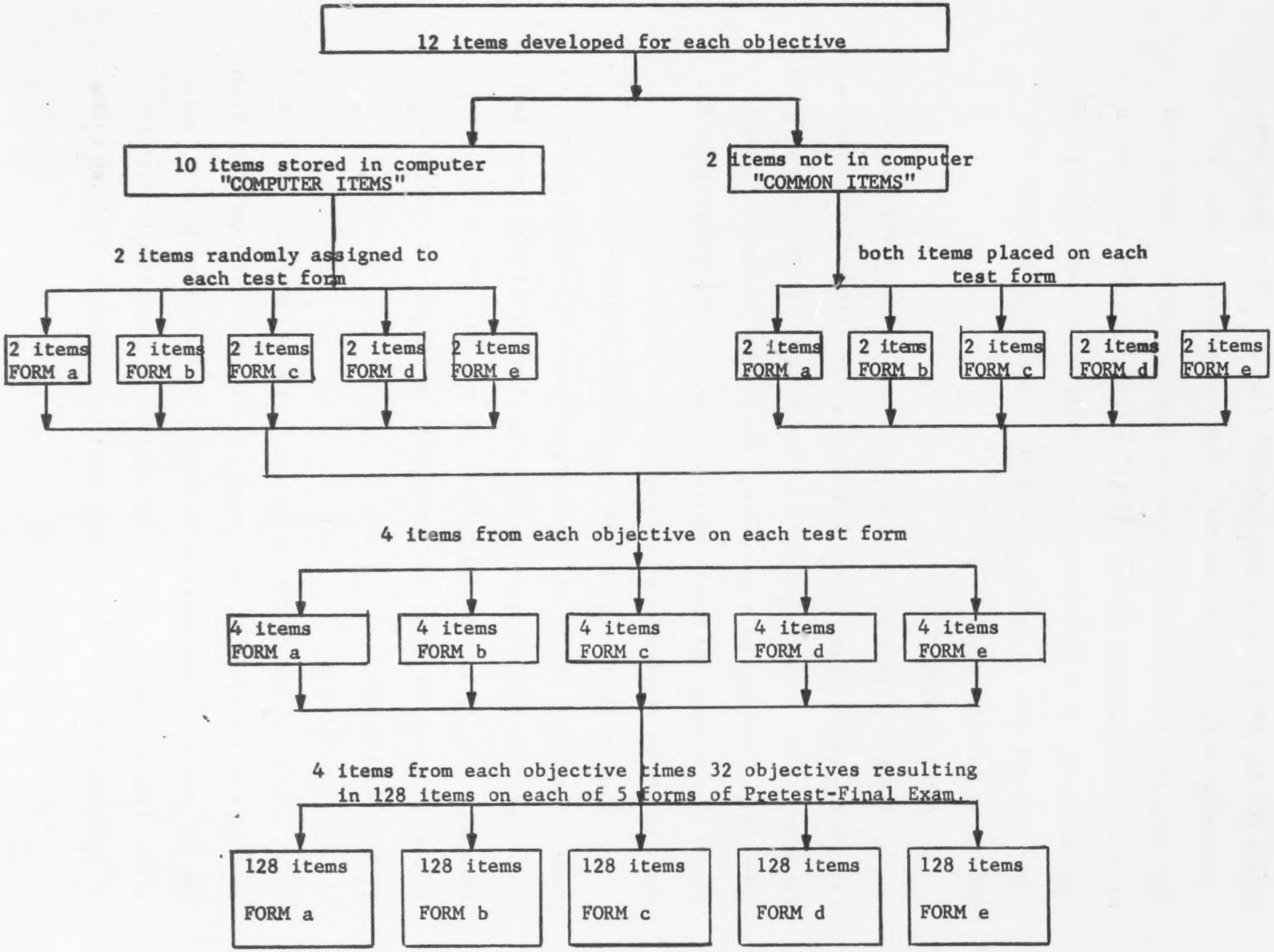

12 items developed for each objective
10 items stored in computer "COMPUTER ITEMS"
2 items not in computer "COMMON ITEMS"
2 items randomly assigned to each test form
both items placed on each test form
2 items FORM a
2 items FORM b
2 items FORM c
2 items FORM d
2 items FORM e
2 items FORM a
2 items FORM b
2 items FORM c
2 items FORM d
2 items FORM e
4 items from each objective on each test form
4 items FORM a
4 items FORM b
4 items FORM c
4 items FORM d
4 items FORM e
4 items from each objective times 32 objectives resulting in 128 items on each of 5 forms of Pretest-Final Exam.
128 items FORM a
128 items FORM b
128 items FORM c
128 items FORM d
128 items FORM e

Fig.1.--Summary of procedures for developing 5 forms of Pretest-Final Examination grades for the CMI students were determined by the sum of their first-pass module posttest scores and their final examination score. In addition, all students were required to complete a written evaluation of four health textbook series. These textbook evaluations, graded by the instructor, were also considered in determining course grades. All other measures used in the study were for experimental purposes only and had no bearing on course grades.

B. Attitude Measures

The principle instruments used to assess student attitudes were: (a) the 40-item Attitude Toward Computer-Managed Instruction Questionnaire (Hagerty, 1970), a modification of a similar scale for computer-assisted instruction developed by Brown (1966); and (b) the 17-item Attitude Toward Health Education Questionnaire, designed by the investigator and based on scales developed by Shaw and Wright (1967).

Hagerty (1970) reported an internal consistency reliability coefficient (KR20) of .88 for the Attitude Toward CMI Questionnaire, and Shaw and Wright (1967) claim that measures constructed with their items indicate reliabilities ranging between .68 and .93. The reliabilities (alpha) obtained for these two instruments in the present study are given in Chapter IV.

C. Time Measures

Three sources of data regarding time were assessed. The first of these was the students' self-report of the amount of time spent studying per module. These data were collected on-line prior to each module test. This display is shown in Appendix C. The second time measure included the number of days to the completion of one-half of the course (defined as completion of 7 module posttests) and to course completion (defined as completion of 14 module posttests). The third time measure was the total latency on the terminal which was recorded automatically by the CAI system.

D. Additional Measures

Additional data of interest included: (a) a single item confidence assessment question given to CMI students each time they selected a module on which they were to be tested (see Appendix B); (b) the Information Questionnaire (Hagerty, 1970) composed of 10 items regarding "expectancy" in terms of course grade, motivation level, and other descriptive items (Appendix H); and the Student Strategy Questionnaire, Forms A and B, which asked the student to characterize his general "studying" strategy and the particular strategy used in Health Education 319, respectively (see Appendices D and E).

Apparatus

The confidence assessment item, study time assessment item, the module posttest items, and the remedial prescriptions, were presented by an IBM 1500 Computer-Assisted Instruction System (IBM, 1967). Terminals for this system consist of a cathode ray tube (CRT), a light pen, and a keyboard. The terminals were located in an air-conditioned, sound-deadened room of Florida State University's CAI Center. Student responses to the aforementioned items as well as the student's total on-line latency were recorded automatically by the CAI system.

Subjects

The sample consisted of 167 students (3 males, 164 females) who enrolled in Health Education 319 for the Fall Academic Quarter, 1970. Forty-one of these students comprised an intact class taught by the instructor in the traditional manner. Hereafter, this treatment is referred to as the classroom instruction, or CI group. The remaining students were randomly assigned to one of three CMI treatment groups.

Experimental Procedures

The treatment period for this study was approximately ten weeks, the length of the Fall Academic Quarter at Florida State University. During the first week of classes (orientation week) students were assigned to the four treatment groups. In addition, the pretest, Attitude Toward Health Education Questionnaire, Information Questionnaire, and Student Strategy Questionnaire (Form A) were administered and an explanation of the course was given.

For the remainder of the quarter, the CMI students proceeded with their off-line study of objectives and appropriate resource materials. When a student felt prepared to be tested, he scheduled terminal time at the CAI Center and was administered the posttest on the module, or modules, of his choice. After the student's module selection, he responded to the confidence and study-time assessment items before receiving the posttest items. These module posttests consisted of five multiple choice items for each objective in the module with knowledge of results provided after each item. These on-line procedures are summarized in Figure 2.

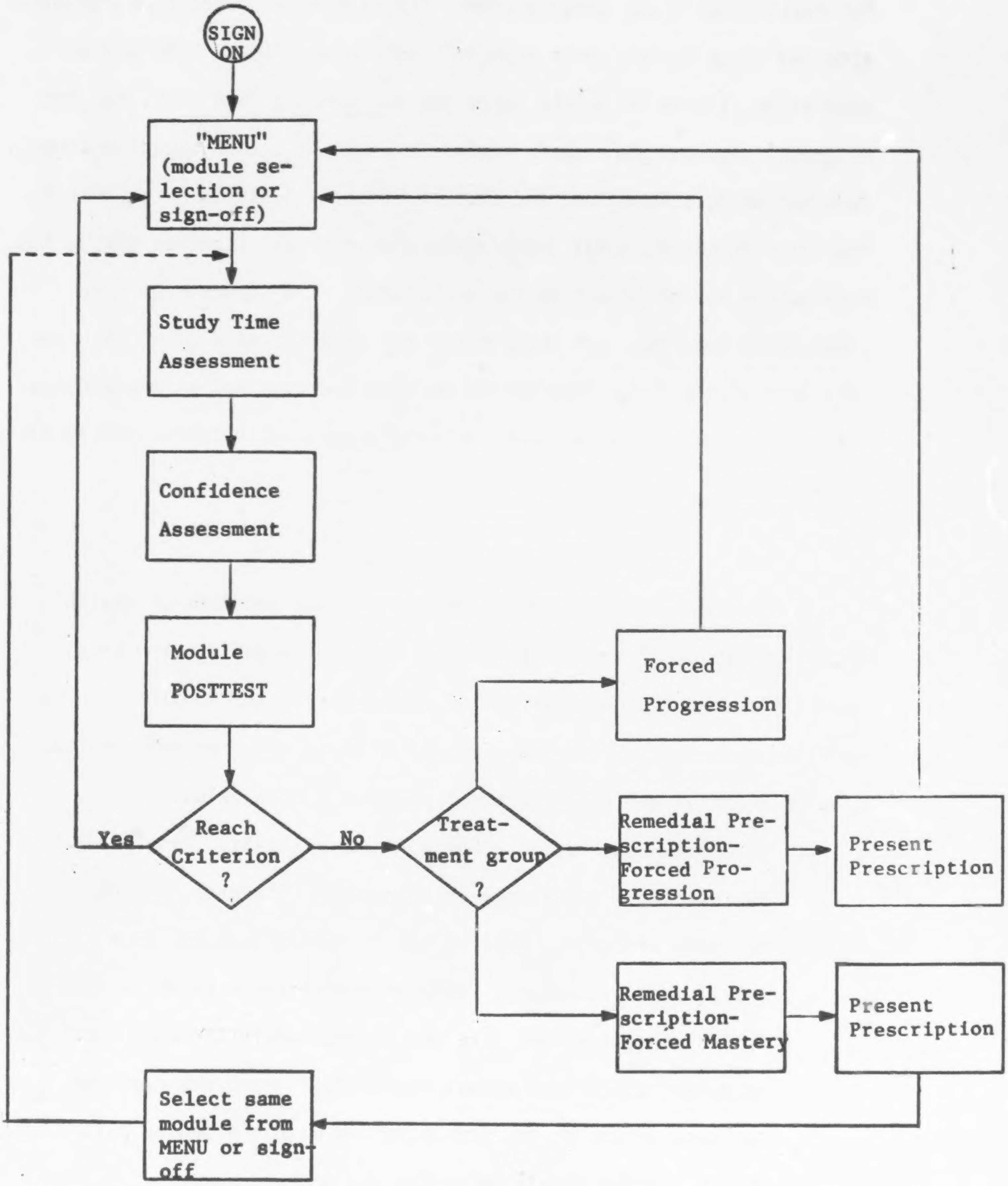

SIGN ON
"MENU" (module selection or sign-off)
Study Time Assessment
Confidence Assessment
Module POSTTEST
Reach Criterion ?
Yes
No
Treatment group ?
Forced Progression
Remedial Prescription-Forced Progression
Present Prescription
Remedial Prescription-Forced Mastery
Present Prescription
Select same module from MENU or sign-off

Fig.2.--Summary of on-line procedures for CMI students

Following the student's seventh module test, the Attitude Toward CMI Questionnaire was administered. The classroom instruction students attended class during their regularly scheduled times. Upon course completion, (after 14 module tests for CMI groups; last class day for CI group) students were again administered the attitude questionnaires, Information Questionnaire, and Student Strategy Questionnaire (Form B). The final examination was group-administered to all students during the examination period scheduled for the course. The pretest and final examination were the same instruments and students were given the same test form on the final examination as they had received on the pretest. The times at which the various instruments were administered are summarized in Table 1.

Experimental Design

As previously mentioned, one of the four sections of Health Education 319 remained an intact class and was taught via the traditional classroom instruction method. Students in the reamining three sections were randomly assigned to one of three CMI treatment groups. A description of the four treatment groups is given below:

1. Remedial Prescription - Forced Mastery (N=42). This group represented a traditonal CMI strategy. Students failing to reach criterion (80%) on one or more objectives in a module were presented a remedial prescription keyed to the failed objectives and directed to reschedule terminal time to repeat the failed module test. This group was required to reach criterion on each objective within a module before making another module selection.

TABLE 1.--Times of administration of instruments used in study

INSTRUMENT	ORIENTATION WEEK	ON-LINE, PRIOR TO EACH MODULE POSTTEST	MIDTERM-6th WEEK FOR CI: AFTER 7th MODULE FOR CMI	END OF COURSE-10th WEEK FOR CI; AFTER 14th FOR MODULE FOR CMI	FINAL EXAM WEEK
Pretest	X				
Final Exam.					X
Att. toward H. Ed.	X			X	
Att. toward CMI*			X	X	
Study time per module*		X			
Confidence *		X			
Information Questionnaire*	X			X	
Strategy Q., Form A	X				
Strategy Q., Form B				X	

*administered to CMI students only

2. Remedial Prescription - Forced Progression (N=46). Students in this group failing to reach criterion on an objective were presented with remedial prescriptions and were given the choice of signing off or selecting another module on which to be tested.
3. Forced Progression (N=38). Students failing to meet criterion on an objective were given the choice of signing off or selecting another module on which to be tested.
4. Classroom Instruction (N=41). This group was taught via the traditional classroom instruction method. This instruction was characterized primarily by lectures and discussion.

Summarized in tabular form the four treatment groups could be contrasted as shown in Table 2.

Table 2.--Summary description of four treatment groups

GROUP	FORCED MASTERY	REMEDIAL PRESCRIPTIONS	MODULE POSTTESTS & KNOWLEDGE OF RESULTS
Remedial Prescription-Forced Mastery	Yes	Yes	Yes
Remedial Prescription-Forced Progression	No	Yes	Yes
Forced Progression	No	No	Yes
Classroom Instruction	No	No	No

In concluding this chapter, two additional points should be made to further clarify the treatment groups. First, for the CMI treatment groups the decison strategy was identical if the student met criterion on the module posttest on his first attempt, viz., he proceeded to the next module of his choice. Thus, the CMI groups were designed to focus on the differential treatment of students failing to meet criterion. Secondly, the entire course sequence for the CMI groups was student selected. That is, these students were free to study resource material for any module and could choose their next module test from the list of those remaining. The exception to this was, of course, the Remedial Prescription-Forced Mastery group, who could only select their next module test after reaching criterion on their prior selection.

CHAPTER IV

RESULTS

The presentation of the results of this investigation is organized into five main sections. The first of these sections presents descriptive data on the instruments used in the study and devotes special emphasis to the various forms of the final examination described earlier in the Methods and Procedures chapter. Sections two, three, and four present comparisons of the four treatment groups on performance, attitude, and time measures, respectively. The fifth and concluding section of the chapter deals with analyses of other dependent measures. These measures include (a) measures of confidence; (b) the Information Questionnaire; and (c) the Student Strategy Questionnaire. A table of power values for the statistical tests presented in this chapter, referenced by Table Number, is given in Appendix I.

I. Descriptive Data for Evaluation Instruments

Since a number of the instruments employed in this investigation were employed without field testing, a summary of descriptive statistics of the principal instruments is presented in Table 3. This table presents sample sizes, means, standard deviations, and alpha reliabilities for: (a) five forms of the pretest and final examination; (b) two administrations of the Attitude Toward Health Education questionnaire; and (c) two administrations of the Attitude Toward Computer Managed Instruction questionnaire. The sample sizes in each treatment group are those given in the preceeding chapter, unless stated otherwise for a particular analysis.

Table 3.--Summary of descriptive statistics of principle dependent measures

Measure	N	Maximum Point Poss.	Mean	Standard Deviation	alpha reliability coefficient
PRETEST					
form a	34	128	54.97	9.29	.74
form b	34	128	59.97	10.46	.79
form c	32	128	51.82	10.40	.79
form d	36	128	60.38	12.16	.84
form e	31	128	52.17	10.25	.79
FINAL EXAM					
form a	33	128	82.83	13.22	.88
form b	33	128	85.23	11.04	.84
form c	29	128	79.89	13.54	.89
form d	34	128	83.61	11.20	.83
form e	30	128	81.07	10.73	.81
ATTITUDE TOWARD HEALTH EDUCATION					
pre	167	85	68.03	7.26	.86
post (14)	165	85	71.23	7.97	.87
ATTITUDE TOWARD COMPUTER MANAGED INSTRUCTION					
midterm (7)	126	200	126.60	18.76	.89
pst (14)	126	200	128.56	18.31	.90

In a one-way analysis of variance (ANOVA) with forms a through e of the pretest comprising 5 levels of the independent variable, and pretest score the dependent variable, the F ratio ($F_{(4,162)} = 3.11$) was significant at the .05 level. A summary of the a posteriori tests (Newman-Keuls) on these test form means is schematically represented as follows:

$\underline{c\ \ e\ \ a\ \ b}\ \ d$

Test forms underlined by a common line do not differ; test forms not underlined by a common line do differ statistically (all tests at the .05 level).

Though these a posteriori tests indicate a differential level of difficulty in test forms, it should be reiterated that the test forms were distributed randomly among the four treatment groups. Therefore, treatment group comparisons with respect to the pretest and final examination were free from bias due to this variation in difficulty of test forms. The analogous F test ($F_{(4,154)}$) for the same test forms on the final exam yielded a non-significant critical F ratio ($p < .05$).

Each of the test forms was composed of "common" items (50%) and "computer" items (50%). To briefly review, the common items were those 64 (2 per objective) common to all test forms. None of the CMI students were exposed to these items during the within-course testing. The computer items (64 on each form) were randomly chosen from the 10-item pool stored in the computer for each objective. Two of these 10 items may or may not have been seen by any given student during the within-course testing because the 5 items given the students on each objective were selected by the random generation function of the IBM 1500 system.

The pretest and final examination means and standard deviations for the common and computer item segments of the 5 test forms are presented in Table 4.

Similarly, Table 5 presented the pretest and final examination means and standard deviations for the common and computer item segments for the four treatment groups.

Table 4.--Pretest and final examination means and standard deviations for the common and computer item portions for the 5 test forms

	Pretest				Final Examination			
	Common		Computer		Common		Computer	
Test form	Mean	SD	Mean	SD	Mean	SD	Mean	SD
A	27.3	4.4	27.4	6.1	39.3	6.6	43.5	7.4
B	27.0	4.9	28.7	6.7	38.8	6.1	46.4	6.6
C	26.2	4.6	25.7	7.0	37.0	5.8	42.9	8.3
D	28.1	5.8	32.2	7.2	38.2	6.3	45.4	5.9
E	23.9	4.3	28.0	6.8	38.0	4.9	43.1	6.9

Table 5.--Pretest and final examination means and standard deviations for the common and computer test item portions for the 4 treatment groups

		Pretest				Final Examination			
		Common		Computer		Common		Computer	
	N	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Remedial Prescription Forced Mastery	40	25.58	5.30	26.45	7.30	38.74	6.27	47.53	6.16
Remedial Prescription Forced Progression	43	26.44	5.06	30.35	6.76	39.28	6.33	46.63	6.06
Forced Progression	35	27.11	4.64	27.74	7.34	37.57	5.57	44.51	6.20
Classroom Instruction	41	26.98	5.33	28.71	7.27	36.00	5.59	38.15	6.42

Two important remarks deserve mention in concluding this description of the common item and computer item test types: First, substantial mean gains were made by all treatment groups on both test types; and second, the CMI treatment groups made relatively greater gains on the computer item portion than on the common item portion. The results presented below will aid in clarifying these remarks.

Table 6 presents the results of a 4 x 2 ANOVA with repeated measures on the second factor. In this instance, the treatment groups comprise the four levels of the first factor, and pretest and final examination scores on the common item portion comprise the two levels of the repeated measures factor. In the above mentioned table, note should be made of the significant repeated measure and treatment by repeated measures interaction (p's <.01). These means are diagrammatically represented in Figure 3a.

Table 6.--Analysis of variance withrepeated measures: four treatment groups on common item portion of pretest and final examination

Source	df	MS	F	P
A (treatment group)	3	26.76	<1	
Subjects within groups	155	43.27		
B (test administration)	1	10382.04	573.85	<.01
AB	3	80.74	80.74	<.01
B x subjects within groups	155	18.09		

Table 7 presents the results of the analogous 4 x 2 ANOVA with pretest and final examination scores on the computer item portion comprising the levels of the repeated measures factor. As was true with the prior analysis, the repeated measures and the treatment by repeated measures interaction were both statistically significant. In addition, this able 7.--Analysis of variance with repeated measures: four treatment groups on computer item portion of pretest and final examination

Source	df	MS	F	p
A (treatment group)	3	391.09	6.12	<.01
Subjects within groups	155	63.88		
B (test administration)	1	19811.64	760.99	<.01
AB	3	457.03	17.56	<.01
B x subjects within groups	155	26.03		

analysis indicated a significant main effect for treatments. These pretest and final examination means for the computer item portion are graphically represented in Figure 3b.

An examination of Figure 3a,b indicates that the CMI treatment groups made relatively greater gains on the computer item portion than on the common item portion. Further verification of this point was obtained by employing a series of nonparametric tests (the sign test). In all cases, the tests used were the normal approximation with correction for continuity, as outlined by Siegel (1956). To obtain the "signs" used for these tests, the following procedure was used: "+" was recorded each time a student's gain from pretest to final examination on the computer portion exceeded his gain on the common portion. Conversely, a "-" was recorded for a student whose common portion gain exceeded his computer portion gain. The frequency of +'s and -'s (and ties) for the four treatment groups are shown in Table 8. In addition, the last two columns

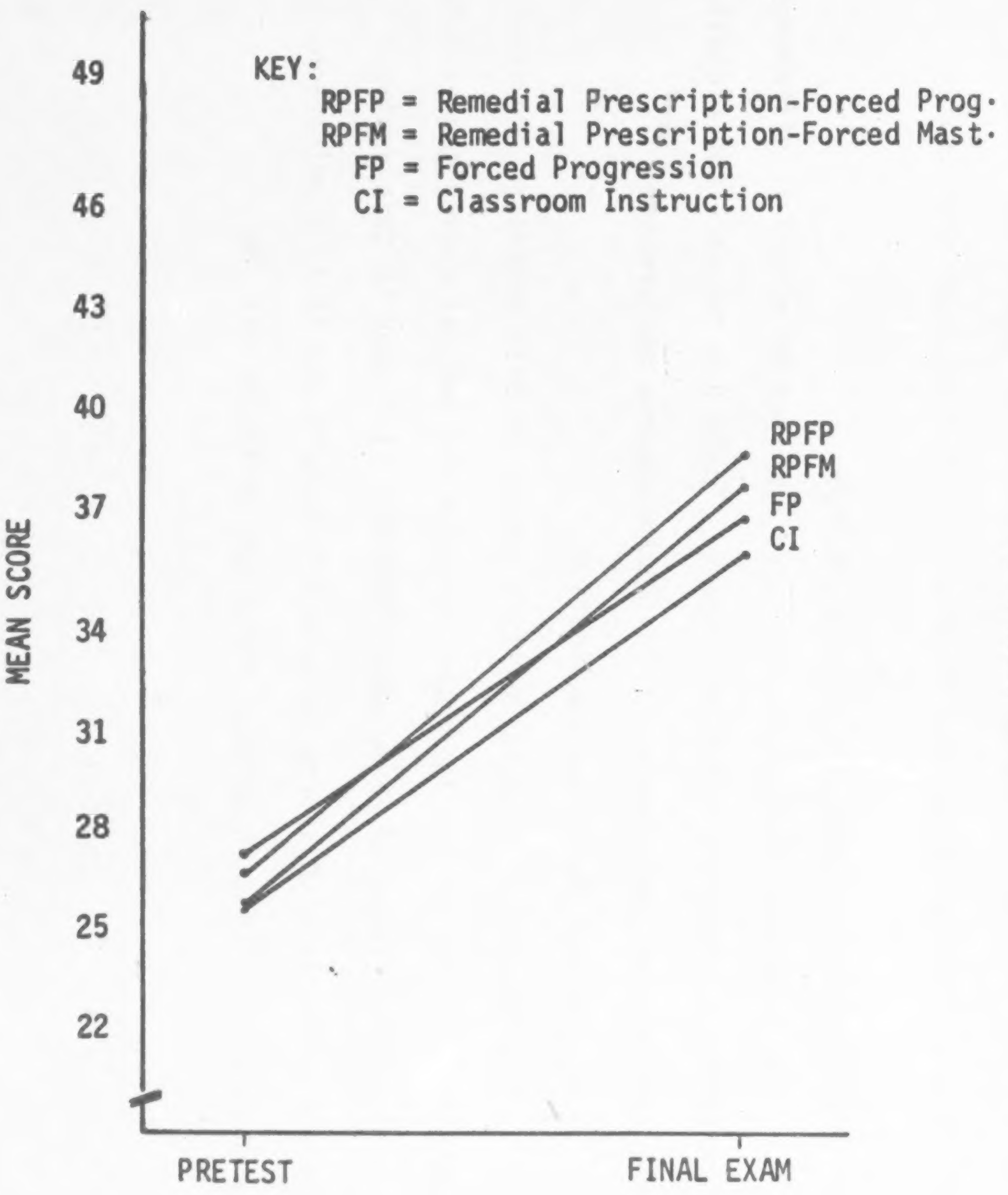


Fig.3a.--Pretest and final examination means on common item portion for 4 treatment groups.

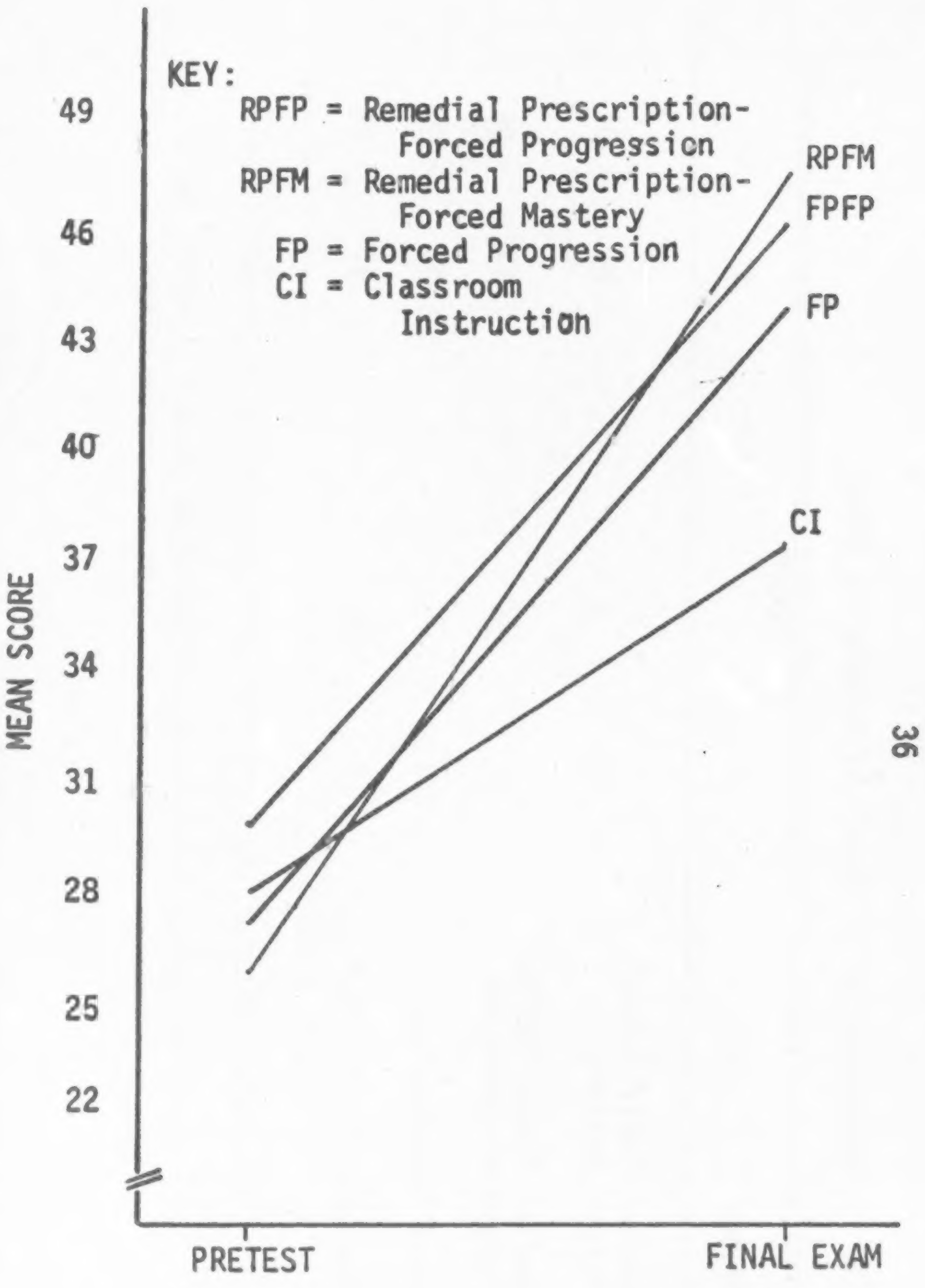


Fig.3b.--Pretest and final examination means on computer item portion for 4 treatment groups.

Table 8.--Frequencies of signs by treatment group

	Sign*				
Group	+	-	0(ties)	*z*	p
Remedial Prescription-Forced Mastery	35	3	2	5.03	<.01
Remedial Prescription-Forced Progression	27	14	2	1.87	.06
Forced Progression	28	5	2	3.83	<.01
Classroom Instruction	18	21	2	.32	.75

*+ indicates computer item portion gain greater than common item portion gain;
- indicates computer portion gain less than common portion gain;
0 indicates computer portion gain = common portion gain.

of this table present the probabilities (two-tailed) associated with the occurrence of the obtained *z*'s calculated for the four sign tests.

II. Treatment Comparisons of Performance Data

Two principle sources of data were employed to ascertain differences in performance among the treatment groups. These sources were the pretest-final examination performance and the within-course performance.

A. Pretest and final examination

The principle analysis for this source of data considers the final examination scores as the dependent variable and pretest scores the covariate in a one-way analysis of covariance (ANCOVA). Included in this analysis were all students with scores on both the pretest and final examination. The obtained correlation between these two variables was .38.

The means and standard deviations for the four treatment groups on both the pretest and final examination are presented in Table 9. It may be noted that (1) there is little difference in mean final examination performance among the computer-managed groups; and that (2) mean performance of the Classroom Instruction group is considerably below that of the other groups. The ANCOVA for these data is presented in Table 10. The obtained F ratio ($F_{3,154} = 14.98$) was sufficient to reject the null hypothesis of no difference among the treatment means after adjusting with the covariate

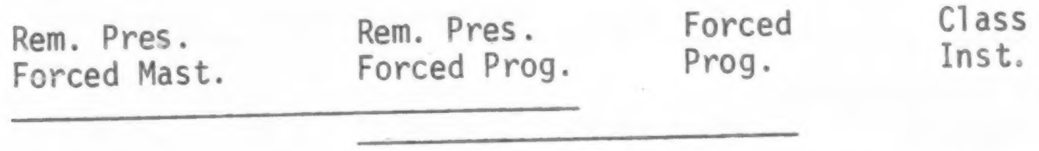
TABLE 9.--Means and standard deviations of four treatment groups for pretest and final examination scores and the final examination means adjusted for the covariate

		Pretest		Final Exam		
Group	N	Mean	Standard Deviation	Mean	Standard Deviation	Adjusted Mean
Remedial Prescription Forced Mastery	40	52.53	11.53	86.65	11.49	87.75
Remedial Prescription Forced Progression	43	56.79	10.38	85.91	10.67	85.11
Forced Progression	35	54.86	10.98	82.09	10.92	82.15
Classroom Instruction	41	55.68	11.62	74.15	11.21	73.85

TABLE 10.--Analysis of covariance summary table for 4 treatment groups: variate = final examination score and covariate = pretest score

Source	df	MS	F	p
Total	157			
Error	154	98.89		
Treatments	3	1481.18	14.98	<.01

at the .01 level of significance. Further, an a posteriori test (Newman-Keuls) on the adjusted criterion means indicated that all three CMI groups differed significantly from the CI group and the Remedial Prescription-Forced Mastery group differed significantly from the Forced Progression group (all tests at the .05 level). Schematically, the summary of the a posteriori tests may be represented as follows:



Treatments underlined by a common line did not differ; treatments not underlined by a common line did differ.

A more detailed presentation of the mean pretest and final examination scores by module are graphically depicted in Figure 4. In order to make comparisons between modules, the mean module scores were converted to a percentage of maximum possible score, as indicated on the ordinate of Figure 2. Inspection of this figure indicates 1) a consistent performance increment by module from pretest to final examination; and 2) the general superiority of the CMI students over the CI students on 12 of the 14 modules.

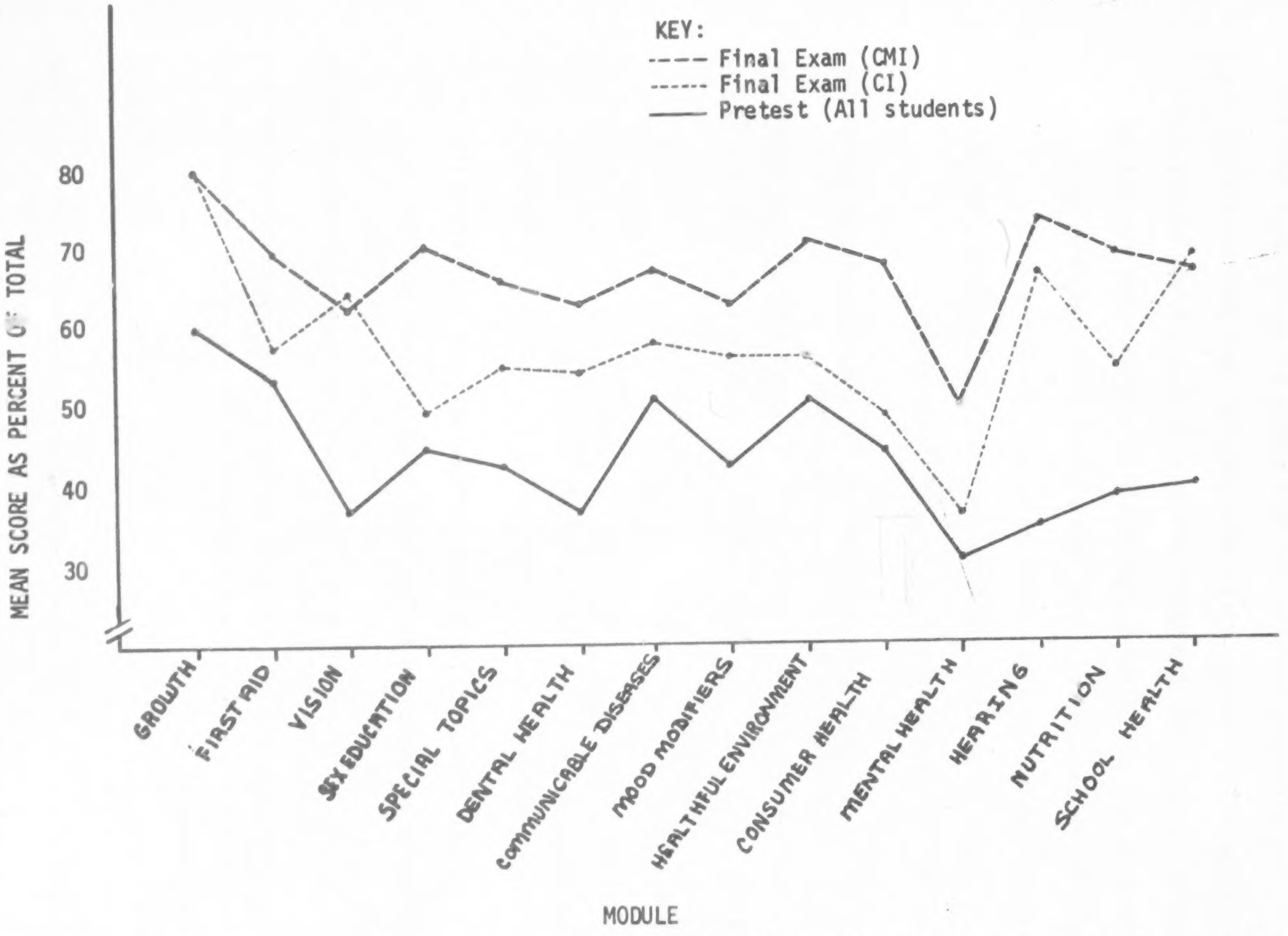


Fig.4.--Mean scores by module expressed as a percentage of possible score: All Ss on pretest (baseline): CI group vs. CMI groups on final exam (middle and top lines, respectively)

B. Within-course performance

The principle analysis for this source of performance data considered the within-course, first pass computer test performance for the three CMI groups. The dependent variable in this one-way analysis of variance is the sum of the 5-item first-pass test scores for the 32 objectives in the course. Thus, the maximum score possible for a particular student on this variable was 160 (i.e., 5 x 32).

Table 11 presents the means and standard deviations for the CMI groups for the within-course, first pass total scores.

TABLE 11.--Means and standard deviations for computer-managed groups for within course first pass total score

GROUP	N	MEAN	MEAN AS % TOTAL	STANDARD DEVIATION
Remedial Prescription Forced Mastery	42	120.19	75	12.54
Remedial Prescription	46	120.80	76	10.51
Forced Progression	38	117.66	74	12.51

These treatment group mean differences were not statistically significant, as indicated in the ANOVA summary shown in Table 12.

TABLE 12.--Analysis of variance: three computer-managed treatment groups on within-course total score

Source	df	MS	f
Between Groups	2	112.18	<1
Within Groups	123	139.86	
Total	125		

A more detailed description of the within-course performance is provided in Figure 5. This figure indicates the mean scores by module (means converted to percentage of maximum possible score) for the three CMI groups. Inspection of this figure indicates 1) a lack of any consistent superiority for a particular group; and 2) that the majority of mean module scores expressed as percents fall below the criterion level of 80%.

A more detailed summary of the number of CMI students reaching criterion on the within course module posttests may be obtained from an examination of Table 13. Again, the similarity of group performance is apparent from an inspection of the % columns. The Remedial Prescription-Forced Mastery group had the highest percentage of students passing on five modules; the Remedial Prescription-Forced Progression on five; and the Forced Progression on four.

TABLE 13.--Number of CMI students reaching criterion (80% correct) on first pass for each of the 14 module tests within the course in each of three treatment groups (N=126)

Module	All CMI Students		Rem. Pres. Forced Mast.		Rem. Pres. Forced Prog.		Forced Prog.	
	N	%	N	%	N	%	N	%
Growth	76	60	28	67	27	59	21	55
First Aid	115	91	40	95	41	89	34	89
Vision	100	79	35	83	39	85	26	68
Sex Education	43	34	21	50	14	30	8	21
Special Topics	90	71	30	71	31	74	29	76
Dental Health	64	51	22	52	22	48	20	53
Communicable Diseases	60	48	17	40	23	50	20	53
Mood Modifiers	54	43	19	45	21	46	14	37
Healthful Environment	37	29	16	38	13	28	8	21
Consumer Health	53	42	18	43	18	39	17	45
Mental Health	32	25	13	31	8	17	11	29
Hearing	100	79	32	76	38	83	30	79
Nutrition	43	34	14	33	16	35	13	34
School Health	69	55	24	57	28	61	17	45

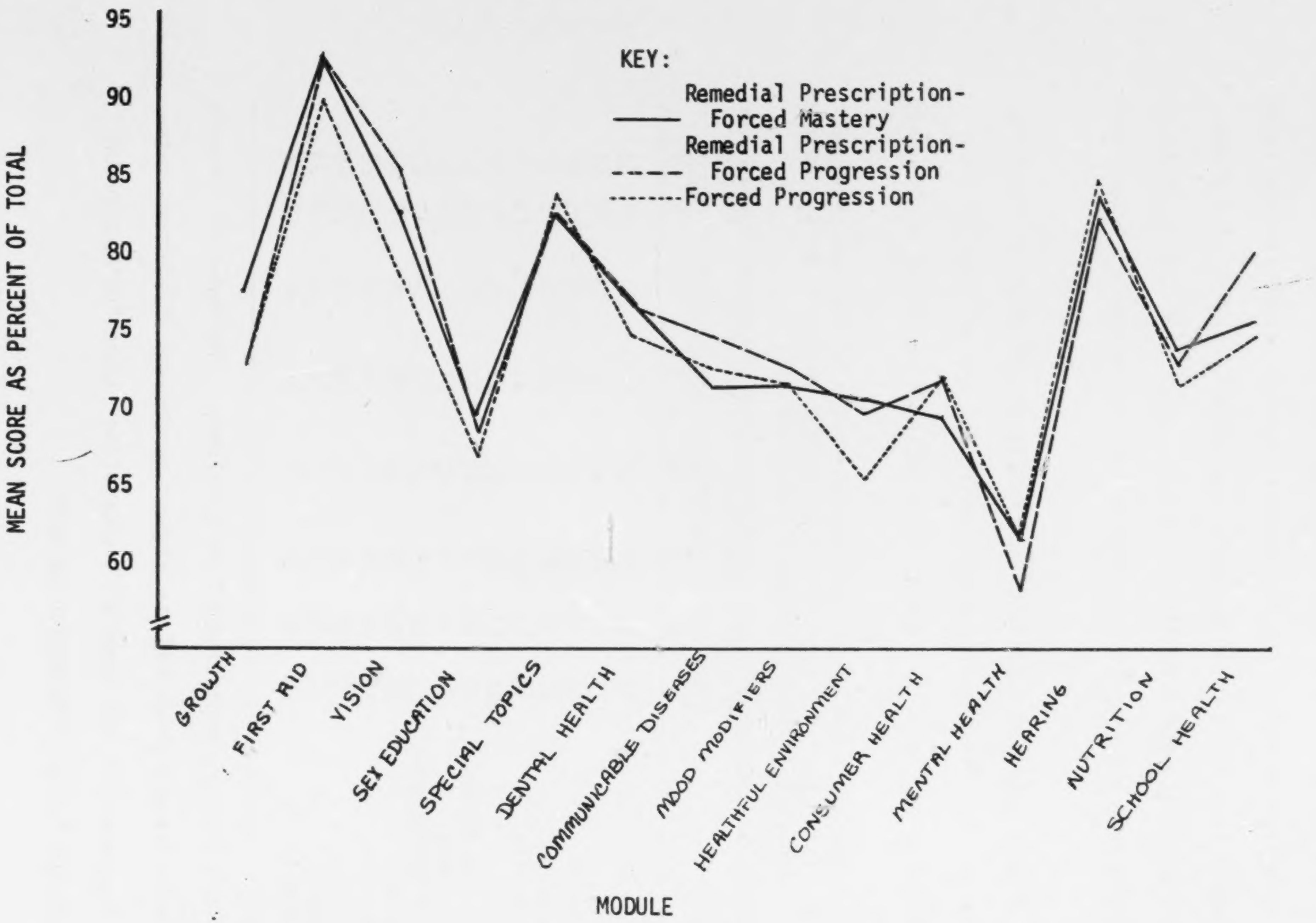


Fig. 5.--Mean scores by module expressed as percentage of possible score for the within-course, first pass module tests for the 3 CMI treatment groups

III. Treatment Comparison of Attitudinal Data

Analyses of the additudinal data are concerned primarily with two dependent measures: (1) Attitude Toward Health Education (see Appendix G); and (2) Attitude Toward Computer-Managed Instruction (see Appendix F). While other types of data collected in this experiment were somewhat attitudinal in nature, this section of the results will be restricted to a discussion of the two aforementioned dependent variables. The presentation format of these data parallels that of the performance data in the previous section; that is, all four treatment groups are first considered in a one-way ANCOVA with the Attitude Toward Health Education scores (final administration) as the dependent measure and the pre-assessment of this same measure as the covariate. The obtained correlation between the two score distributions was .46. The means and standard deviations for both the pre and final assessment on this instrument are presented in Table 14. It may be noted that

TABLE 14.--Means and standard deviations of 4 treatment groups for the pre and final administration of the Attitude Toward Health Education

	Pre-Assessment		Final Assessment		
Group	Mean	Standard Deviation	Mean	Standard Deviation	Adjusted Mean
Remedial Prescription-Forced Mastery	69.51	6.70	73.51	7.36	72.83
Remedial Prescription Forced Progression	68.07	6.49	70.32	8.16	70.38
Forced Progression	67.00	7.42	72.22	8.68	72.85
Classroom Instruction	68.30	6.70	71.40	7.57	71.35

there is very little difference in mean scores between the four treatment groups on either administration. The ANCOVA for these data is presented in Table 15. The absence of any statistically significant mean differences lends credence to the assertion that the students' attitudes toward health education, as herein assessed, was not influenced by treatment group assignment.

TABLE 15.--Analysis of covariance summary table: variate = final assessment and covariate = pre assessment of Attitude Toward Health Education

Source	df	MS	F
Total	163		
Error	160	46.71	
Treatments	3	55.89	1.20

The second measure of attitude is represented by scores on the Attitude Toward Computer-Managed Instruction questionnaire. This scale was administered to the students in the CMI treatment groups upon completion of the 7th and 14th module tests. The means and standard deviations for these three treatment groups on the Attitude Toward Computer-Managed Instruction questionnaire are presented in Table 16. These means reflect a generally positive attitude given that a scale value of 100 represents the median, or neutral position.

TABLE 16.--Means and standard deviations of CMI groups for the midterm and final administration of the Attitude Toward Computer-Managed Instruction

Group	N	Mid-term Assessment Mean	Mid-term Assessment Standard Deviation	Final Assessment Mean	Final Assessment Standard Deviation
Remedial Prescription Forced Mastery	42	127.33	18.35	129.24	17.71
Remedial Prescription Forced Progression	46	124.61	19.65	126.33	17.75
Forced Progression	38	126.97	17.88	129.00	18.47

Table 17 presents the ANOVA for these results. Again no statistically significant mean differences in attitudes were present.

TABLE 17.--Analysis of variance: three CMI treatment groups on two repeated measures (midterm and final administrations) of the Attitude Toward Computer-Managed Instruction scale

Source	df	MS	F
Between (A)	2	210.98	<1
Error Between	123	586.76	
Repeated Measure (B)	1	221.02	2.59 N.S.
A x B	2	.51	<1
Error Within	123	85.46	
Total	251		

IV. Treatment Comparison of Time Data

Because the three principle indices of time employed in this study were not applicable to the classroom instruction treatment group, this section is limited to a consideration of the three computer-managed treatment groups.

Index 1. Time spent studying per module (hours).

This index of time was the students' self-report to the approximate number of hours spent studying for each of the 14 modules. This data was collected on line prior to each module posttest (see Appendix C). The 14 correlations between module scores and all the students' self-reports of time spent studying on the respective modules are presented in Table 18.

TABLE 18.--Correlations (r) between module scores and self-reports of time spent studying for that module for the combined CMI groups (N=126)

	Module													
	1	2	3	4	5	6	7	8	9	10	11	12	13	14
r	.21*	.18	.20*	.42**	.21*	.07	.29**	.27**	.30**	.13	.25**	.30**	.11	.27**

*p < .05
**p < .01

These 14 separate time ratings (in approximate hours) were summed for each student and the treatment group means and standard deviations are given in Table 19. These mean differences were not statistically significant (F(2,123)<1).

TABLE 19.--Means and standard deviations of total reported study time (in hours) for the three computer-managed treatment groups (N=126)

Group	N	Mean	Standard Deviation
Remedial Prescription-Forced Mastery	42	35.14	12.74
Remedial Prescription-Forced Progression	46	35.78	11.72
Forced Progression	38	38.21	11.40

Finally correlations between this index of total study time and four principle dependent variables are presented in Table 20.

TABLE 20.--Correlations between index of total student study time and four principle dependent measures for all CMI students (N=126)

Dependent Measure	r
Final examination	.34**
Within course first-pass score	.37**
Attitude toward health education	.15
Attitude toward computer-managed instruction	-.14

$^{**}p < .01$

Index 2. Time to completion of mid-term and course (days).

The second index of time consists of two related components: a) the number of days taken to complete 7 of the 14 module tests, defined as "midterm"; and b) the number of days taken to complete all 14 module tests, defined as "course completion." In each case, the number of days was based upon the total number of computer days available for the fall academic quarter, in this instance, fifty. To exemplify, a student who completed his seventh module test on the 28th available computer day, and his fourteenth module test on the 45th available day, was given indices of 28 and 45 for the completion of midterm and course, respectively. Table 21 presents the means and standard deviations for these two indices for the computer-managed treatment groups. Considering each of the indices in separate ANOVA's, the F ratios were not statistically significant.

TABLE 21.--Means and standard deviations for number of days to completion of midterm and course for the computer-managed treatment groups (N=126)

		Midterm Completion		Course Completion	
Group	N	Mean	Standard Deviation	Mean	Standard Deviation
Remedial Prescription Forced Mastery	42	30.93	8.23	45.91	2.46
Remedial Prescription Forced Progression	46	29.57	8.83	44.80	3.43
Forced Progression	38	28.37	9.13	45.16	3.27

Finally, Table 22 presents the correlations of these two related time indices with four principal dependent variables.

TABLE 22.--Correlations between days to completion of midterm and course with four principal dependent measures for the CMI students (N=126)

Dependent Measure	r midterm completion	r course completion
Final examination	-.11	.08
Within course total score	-.21*	.03
Attitude toward health education	-.07	.06
Attitude toward computer-managed instruction	-.13	-.01

*p < .05

Index 3. Total latency on computer system (minutes).

The third and final index of time considered was the total on-line time for each student. This cumulative latency represents the total amount of time that each student was actively engaged in student-terminal interaction. Table 23 presents the means and standard deviations of total latency (in minutes) for the three computer-managed treatment groups. As can be seen from an inspection of this table,

TABLE 23.--Means and standard deviations of total latency (in minutes) for the three computer-managed treatment groups

Group	N	Mean	Standard Deviation
All CMI groups	126	214.33	166.52
Remedial Prescription Forced Mastery	42	257.44	145.34
Remedial Prescription Forced Progression	46	160.52	59.35
Forced Progression	38	233.87	246.00

the Remedial Prescription-Forced Progression group had the least mean latency, while the Remedial Prescription Forced Mastery group had the greatest. A high degree of variability in system latency both within and across treatment groups is indicated by the rather large and disparate standard deviations. The ANOVA for these data is presented in Table 24.

TABLE 24.--Analysis of variance: three computer-managed treatment groups on total latency

Source	df	MS	F	p
Between groups	2	111937.94	4.21	$<.05$
Within groups	123	26564.52		
Total	125			

A summary of the a posteriori tests (Newman-Keuls) on these computer latency means is schematically represented as follows:

Remedial Prescription-Forced Progression	Forced-Progression	Remedial Prescription-Forced Mastery

Treatment groups underlined by a common line did not differ; treatment groups not underlined by a common line did differ (all tests at the .05 level). Due to the heterogeneity of variance among the group latencies, these data are reported for descriptive purposes only.

V. Treatment Comparisons of Additional Data

This concluding section deals with data related to three self-report measures. These three measures are as follows: (a) the assessment of student confidence (see Appendix B), administered on-line prior to each of the 14 module tests; (b) the Information Questionnaire (see Appendix H), administered to all students in the first week of class and to each student individually upon completion of the 14th module test; and (c) the Student Strategy Questionnaire, Form A (see Appendix D), administered in the first week of classes and Form B (see Appendix E), upon completion of the 14 modules.

The order of presentation of these data will follow that suggested above. Some of the data are presented in an effort to reflect treatment group differences *per se*, while other results are reported simply to aid in characterizing the behavior of all students during the course.

A. Confidence Measure

It should be noted at this point that the confidence scale was administered on-line, and therefore applies to the CMI treatment groups only. The 14 correlations between module scores and the student's self-report of confidence for that respective module are presented in Table 25.

TABLE 25.--Correlations between module scores and self-reports of confidence for all CMI students (N=126)

	Module													
	1	2	3	4	5	6	7	8	9	10	11	12	13	14
r	.22*	.21*	.24*	.33**	.17	.19	.33**	.32**	.25**	.09	.21*	.23*	.07	.20*

* p < .05
** p < .01

The magnitufe of these correlation coefficients parallels closely those between module scores and time spent studying per module. This is apparent from a comparison of Tables 25 and 18.

The relatively large correlation coefficients between the students' reported studying time per module and self-reports of confidence shown in Table 26 provide some degree of construct validity for both measures.

TABLE 26.--Correlations between time spent studying and confidence for each of the 14 modules for all CMI students (N=126)

	Module													
	1	2	3	4	5	6	7	8	9	10	11	12	13	14
r	.59**	.13	.65**	.72**	.67**	.56**	.48**	.62**	.75**	.76**	.68**	.56**	.68**	.70**

$^*p < .05$
$^{**}p < .01$

That is, it is reasonable to expect that those students who reported spending more time in preparation for each module test would in turn report higher levels of confidence. Thus, the substantial correlations reported in Table 26 would, to a degree, verify this line of reasoning.

In order to derive an index of confidence useful in discerning possible treatment group differences, the 14 seperate confidence assessments were summed for each student. The treatment group means and standard deviations for this index of total confidence are presented in Table 27. These mean differences were not statistically significant ($F_{(2,123)} < 1$). The correlation coefficients between this index of total confidence and five other principle dependent variables are presented in Table 28.

TABLE 27.--Means and standard deviations of total reported confidence assessments for the three CMI treatment groups (N=126)

GROUP	N	MEAN	STANDARD DEVIATION
Remedial Prescription-Forced Mastery	42	43.69	10.13
Remedial Prescription-Forced Progression	46	45.52	10.87
Forced Progression	38	44.24	9.39

TABLE 28.--Correlation coeffieients between index of total confidence and five principle dependent variables for all CMI Ss (N=126)

DEPENDENT MEASURE	r
Final Examination	.30**
Within course total score	.37**
Attitude Toward Health Education	-.01
Attitude Toward Computer Managed Instruction	-.17
Total of reported study time	.71**

$^{**}p < .01$

B. Information Questionnaire

Items 1, 2, and 3 of the Information Questionnaire (see Appendix H) were administered to all students during the first week of class. All 10 items were administered to the classroom instruction group during the last week of classes; and to the computer-managed groups upon completion of the 14th module.

At the beginning of the course, when asked what grade they expected to receive in the course, 82 (50%) of the students responded "A," 72 (44%) responded "B." and 11 (6%) responded "C." The responses to the same question upon course completion indicate a substantial shift for both the CMI and CI groups (χ^2's < .01). These frequencies are as follows: 44 (27%) responded "A." 92 (56%) "B," 25 (15%) "C," 1 (1%) "D," and 1 (1%) "F." These response frequencies and those of the CMI groups compared with those of the classroom-instruction group, are presented in Table 29.

TABLE 29.--Expected course grades for the CMI and CI groups for pre and post administrations of the Information Questionnaire by figuring and percentage (N=165 pre; 163 post)

	PRE						POST					
	ALL Ss		CMI		CI		ALL Ss		CMI		CI	
Category	N	%	N	%	N	%	N	%	N	%	N	%
A	82	50	58	47	24	49	44	27	26	21	18	44
B	72	44	58	47	14	29	92	56	69	57	23	56
C	11	6	8	6	11	22	25	15	25	20	--	--
D	--	--	--	--	--	--	1	1	1	1	--	--
F	--	--	--	--	--	--	1	1	1	1	--	--

Item 2 of the Information Questionnaire asked students their attitude toward their cou-se grade at that time in the quarter. This item was also administered pre and post to all students. The frequency of responses for all students and the combined CMI groups vs. the CI group is given in Table 30.

TABLE 30.--Attitude toward course grades for the CMI and CI groups on the pre and post administrations of the Information Questionnaire by frequency and percentage (N=165)

	Pre						Post					
	All Ss		CMI		CI		All Ss		CMI		CI	
Category	N	%	N	%	N	%	N	%	N	%	N	%
Very concerned	70	42	52	42	18	44	70	42	56	45	14	34
Somewhat concerned	84	51	64	52	20	49	88	53	63	51	25	61
Not at all concerned	11	7	8	6	3	7	7	5	5	4	2	5

X^2 tests for both the CMI and CI groups indicated no significant frequency shifts from the pre to post administrations (X^2's < .01).

The third item of the Information Questionnaire (and the last to be given pre and post) asked the question, "At this point in the course, how would you rate your level of motivation to do well in the course?" The frequency of responses for all students and for the combined CMI groups vs. the CI group is given in Table 31. An examination of the first and second categories in this table would indicate a rather substantial shift

TABLE 31.--Level of motivation to do well in the course for the pre and post administrations of the Information Questionnaire by frequency and percentages (N=165)

	Pre						Post					
	All Ss		CMI		CI		All Ss		CMI		CI	
Category	N	%	N	%	N	%	N	%	N	%	N	%
Very highly motivated	110	67	80	64	30	73	70	42	47	38	23	56
Somewhat motivated	49	30	38	31	11	27	74	45	58	46	16	40
Only slightly motivated	6	3	6	5	--	--	18	11	17	14	1	2
Not at all motivated --	--	--	--	--	--	--	3	2	2	--	1	2

in motivation level from the pre to post administration for both the CMI and CI group (X^2's < .05).

Item 4 of the Information Questionnaire was considered appropriate only for the CMI groups on the post administration. The response frequencies in each category for the combined CMI groups and the separate CMI treatment groups are presented in Table 32. Responses to this particular item, perhaps more than any other single item, reflect the student's overall degree of satisfaction with the CMI experience. The value of χ^2 resulting from the above 4 x 3 chi-square contengency table was not statistically significant (p < .05).

TABLE 32.--Student attitudes toward taking another course by computer-managed instruction for the CMI treatment groups (N=124)

Category	All CMI Students		Rem. Pres.-Forced Mast.		Rem. Pres.-Forced Prog.		Forced Prog.	
	N	%	N	%	N	%	N	%
Gladly	17	14	4	10	6	13	7	19
Possibly	63	51	22	51	26	58	15	41
Reluctantly	28	23	12	29	8	18	8	21
Never	16	12	4	10	5	11	7	19

Responses to item 5 of the Information Questionnaire are presented in Table 33. Though the question, "Did you feel you learned what was expected of you as indicated by the objectives?" was more germaine to the CMI students, the responses of the CI group are also included.

TABLE 33.--Numbers and percentages of CMI and CI students who felt they learned what was expected of them as indicated by the objectives (N=165)

Category	All Ss		CMI		CI	
	N	%	N	%	N	%
Yes	111	67	76	61	35	85
Don't know	34	21	30	24	4	10
No	20	12	18	15	2	5

Item 6 of the Information Questionnaire, "Did you feel the material in this course is relevant to your professional goals?" was appropriate to all students. An examination of Table 34 reveals a preponderance of responses in categories 1 and 2. On the basis of the responses to this item, it would seem that the vast majority of students in all groups considered the content included in Health Education 319 to be at least as relevant to their professional goals as other courses in their curricula.

TABLE 34.--Numbers and percentages of CMI and CI students who felt that the material in the course was relevant to their professional goals (N=165)

Category			GROUP			
	All Ss		CMI		CI	
	N	%	N	%	N	%
More relevant than other courses	56	34	45	36	11	27
As relevant as other courses	99	60	71	57	28	68
Less relevant	9	5	7	6	2	5
Not at all relevant to my goals	1	1	1	1	--	--

Item 7 of this Questionnaire, "Would you have preferred 'text and lecture' classes?" was appropriate, as was Item 4, to the CMI group only. The response frequencies to this item are given in Table 35. The value of the obtained χ^2 resulting from this 3 x 3 χ^2 contingency table was not statistically significant ($p < .05$).

TABLE 35.--Number and percentages of CMI students by group who expressed a preference for text and lecture classes (N=124)

			GROUP					
	All CMI Ss		Rem. Pres.-Forced M.		Rem. Pres.-Forced Prog.		Forced Prog.	
Category	N	%	N	%	N	%	N	%
Absolutely, for this course	32	26	8	19	13	29	11	30
Maybe	54	44	22	52	18	40	14	38
Not at all, for this course	38	31	12	39	14	31	12	32

Questions 8, 9, and 10 of the Information Questionnaire asked the students to estimate the approximate number of times they interacted with the professor, graduate assistants, and fellow students, respectively. Because of the similiarity of these items the means and standard deviations are presented in a single table (see Table 36). Blanks were not considered as responses, i.e., only responses of "0" or "none" were considered as having no interaction.

TABLE 36.--Means and standard deviations of the number of interactions with professor, graduate assistants, and fellow students for the 4 treatment groups (N=165)

Interaction with:		All Groups	Rem. Pres.- Forced Mas.	GROUP Rem. Pres.- Forced Prog.	Forced Prog.	CI
Professor	Mean	2.07	1.69	1.38	1.59	3.66
	SD	2.28	2.23	1.50	1.21	2.98
Graduate Assistants	Mean	4.11	6.10	4.29	3.89	2.10
	SD	5.30	6.63	4.25	4.43	4.94
Fellow Students	Mean	4.12	2.81	5.00	5.19	3.59
	SD	4.80	3.07	5.48	6.49	3.43

C. Student Strategy Questionnaire, Forms A and B

This concluding section deals with student responses to Form A (see Appendix D) and Form B (see Appendix E) of the Student Questionnaire. It should be noted that the 5 strategy descriptions are identical on the two forms, only the directions are slightly modified. Form A, administered during the first week of classes, required the student to rate himself on each strategy as to how typical it was of his general strategy. Form B, administered upon completion of the 14th module for the CMI students, and during the last week of classes for the CI students, asked the student to rate each strategy in terms of its similiarity to that which he used in Health Education 319. The given strategies, with brief descriptors for each, are provided below:

Strategy 1: Puts off studying as long as possible--procrastinates
Strategy 2: Completes work at steady, consistent rate
Strategy 3: Studies only topics of interest
Strategy 4: Studies only topics on which prior knowledge is unsatisfactory

Strategy 5: Studies everything that is recommended--
primary and secondary references

On both forms, the last item instructs the student to indicate which of the five strategies was most like his own--in general on Form A, and specifically in HEE 319 on Form B. This last item is the subject of the analyses reported in this section. Further, it should be noted that the five strategies described are not mutually exclusive categories, and for this reason, a certain degree of error was introduced when the student was forced to choose that strategy which was most like his own. In this regard, the following deserves mention: If a student responded reliably to this last item, one would expect that the choice of his most typical strategy would be the same as that rated highest of the five preceeding items. For example, if a student were to give Strategy number 3 a rating of 8 while rating the other strategies less than 8, one would expect his choice of most typical strategy would be number 3. The actual occurrence of such cases on Form A was 140 of 165 (85%) and 134 of 165 (81%) on Form B.

Response frequencies on this last item of both forms for the 4 treatment groups are presented in Table 37. Of particular interest in the use of two forms of the questionnaire was to detect possible changes in typical student strategies from the pre to post assessments. Separate chi square tests for the four treatment groups, using Form A to obtain the expected frequencies, and Form B for the observed frequencies, would have aided in discerning possible strategy changes due to the respective groups. However, these tests were not undertaken due to the small

TABLE 37.--Frequencies of most typical strategy on Forms A and B of the Student Strategy Questionnaire for the 4 treatment groups

Treatment Group		Most Typical Strategy 1	2	3	4	5
Remedial Prescription-Forced Mastery	(Form A)	8	15	5	7	7
	(Form B)	14	13	6	6	3
Remedial Prescription-Forced Progression	(Form A)	7	18	8	5	7
	(Form B)	12	17	2	6	8
Forced Progression	(Form A)	7	15	7	3	5
	(Form B)	6	9	7	4	11
Classroom-Instruction	(Form A)	11	14	4	5	7
	(Form B)	18	15	1	4	3

expected frequencies in some of the cells. Instead, the CMI groups' data were combined, and categories 3, 4, and 5 of the questionnaire were combined for both the CMI and CI groups. This resulted in the two contingency tables presented in Table 40. The resulting value of

TABLE 38.--Chi-square contingency tables: Form A = expected frequencies; Form B = observed frequencies for CMI (a) and CI (b)groups

		Most Typical Strategy 1	2	3-5
CMI groups	(Form A)	22	48	54
	(Form B)	32	39	53
CI group	(Form A)	11	14	16
	(Form B)	18	15	8

χ^2 for the CMI groups, using Form A responses as the expected frequencies was equal to 6.25 (df = 2), which is statistically significant ($p < .05$). The analogous test on the CI group with the same degrees of freedom yielded a $\chi^2 = 8.53$, which is also significant beyond the .05 level.

Through the combining of categories 3, 4, and 5 makes interpretation difficult with respect to individual strategies, the above evidence suggests that substantial changes in typical strategy did take place for both the CMI and CI groups. An elaboration of this point will be reserved for the Discussion section.

Finally, Tables 39 and 40 are presented to aid in describing the relationship between typical student strategies and final examination scores. Table 39 presents the mean final examination scores for the CMI and CI groups for students selecting each of the respective strategies as most typical of their own on the pre assessment (Form A). Similarily, Table 40 presents the mean final examination scores for the CMI and CI groups, based upon the most typical strategy selected on the post assessment (Form B).

TABLE 39.--Means on final examination for CMI and CI Ss selecting the respective strategies as most typical on Student Strategy Questionnaire, Form A (N=165)

	CMI		CI	
Most typical strategy	N	Mean	N	Mean
1	22	86.86	11	72.00
2	48	85.92	14	79.14
3	20	78.45	4	63.75
4	17	84.94	4	71.00
5	17	86.76	6	76.00

TABLE 40.--Means on final examination for CMI and CI Ss selecting the respective strategies as most typical on Student Strategy Questionnaire, Form B (N=163)

	CMI		CI	
Most typical strategy	N	Mean	N	Mean
1	32	85.41	18	71.28
2	38	86.97	14	75.29
3	15	80.20	1	-----
4	18	82.72	4	76.75
5	21	85.38	2	84.00

In some cases these final examination means are based on a very small number of students, making a strict interpretation unwarranted. However, one observation deserves mention. This is that students selecting Strategy 3 as most typical of their own on both assessments had the lowest mean final examination score. This was true for both CMI and CI students, excepting the one CI, Strategy 3 student in Table 40, for which a mean score was incalculable. Further discussion regarding the overall results on the Student Strategy Questionnaire shall be deferred until the following chapter.

CHAPTER V

DISCUSSION

One of the principle objectives of the present study was to determine the differential effect of four instructional treatments. To achieve this objective a variety of evaluative instruments and self-report measures were employed. The rationale for using measures of performance and attitudes is straightforward. The rationale for the assessment of study time, confidence, student strategies, and the items of the Information Questionnaire was one of attempting to characterize the more subtle behavioral patterns of students throughout the course.

Both descriptive and inferential statistics were used in an effort to discern differences among the CMI groups and between the CMI and CI groups. With respect to performance, both types of comparisons were reported. Specifically, all groups were compared on the final examination while comparisons of within-course performance were restricted to the CMI groups. The superiority of the CMI groups over the CI group (see Tables 9, 10 and Fig. 4) on final examination performance can be attributed to at least three factors. The first of these factors relates to the positive effects associated with frequent testing enhanced by immediate knowledge of results. It could be argued that these positive effects were simply due to the increased practice in responding to the test items afforded the CMI groups. However, the mean final examination performance of the Remedial Prescription-Forced Mastery group was not significantly greater than that of the Remedial Prescription-Forced Progression group. Thus, while the effects of practice could partially explain differences in performance between the CMI and CI groups, an alternative interpretation is warranted. This alternative interpretation to explain the effects of frequent testing is that it provided the CMI students with a greater familiarity with the content objectives and a better understanding of the criteria used in evaluating the attainment of those objectives. This knowledge would have aided the CMI students in focusing their attention on the relevant portions of the resource material as well as providing a relative index of the study time required to reach expected performance levels.

The second factor relates to the differential emphasis placed on topic areas between the two groups; i.e., the lack of a one-to-one correspondence in content coverage between the resource material given the CMI students and the resource material emphasized by the instruction of the CMI group.

The third and final factor is related to possible differences in levels of motivation to do well on the final examination. Specifically, an uncontrolled source of error was introduced by the instructor of the CI students on the last day of classes. The instructor administered his own version of a final examination, informing the students that they were required to take the group-administered final examination but that their scores on his version, rather than their scores on the group version would be considered in determining course grades. While the CI students did take the group-administered test, and appeared to take as much time in responding as did the CMI students, this methodological error makes the assumption of equal motivation levels between the two groups questionable.

Final examination comparisons among the three CMI groups means failed to substantiate the efficacy of requiring forced mastery only or of providing remedial prescriptions only. This is evidenced by the fact that the Remedial Prescription - Forced Mastery group did significantly better than the Forced Progression group, but the mean differences between: (a) Remedial Prescription - Forced Mastery vs. Remedial Prescription - Forced Progression; and (b) Remedial Prescription - Forced Progression vs. Forced Progression were not statistically significant. This lack of clear superiority effected by requiring mastery or by providing remedial prescriptions is consistent with the equality of within-course performance among the CMI groups. Collectively, these performance data support the interpretation that the differences among the CMI treatment conditions were far outweighed by their similarity. Stated differently, it would appear that the effects of content organization, presentation format, and frequent testing over-shadowed the more subtle effects associated with the differential treatment characteristics.

With respect to the requirement of mastery, it should be emphasized that there was no apparent hierarchical structure among the fourteen modules. Thus, the interpretation that requiring mastery is not advantageous for all content areas is probably unwarranted. The achievement of mastery on the fundamental concepts in more highly structured disciplines such as physics or chemistry may be critical to the understanding of higher order concepts. Further, it is possible that real treatment effects in this study were masked by extraneous sources of variation due to the first course implementation. It is conceivable that such treatment effects would be detected after one or two iterations of the course revision process.

In addition, two methodological considerations concerning the performance comparisons among the CMI groups deserve mention. First, in the Forced Mastery condition, it was intended that students failing to reach criterion be sent off-line for further study prior to retaking the failed module test. In reality this was not always the case. In some instances, such students repeated the failed test immediately without benefit of the anticipated off-line study, thereby diminishing any beneficial effects associated with the condition. Second, there was no assurance that groups presented with remedial prescriptions did, in fact, fulfull the implicit assumption of the treatment, viz., to do that which was prescribed.

Even with these limitations in mind, of the three CMI groups, the Remedial Prescription - Forced Progression treatment appeared to be the most efficient in terms of cost. On the average, these students used an hour less terminal time than the Forced Progression group and 1.5 hours less than the Remedial Prescription - Forced Mastery group (see Table 23). There was, however, an important source of error in the on-line latency data. This error was introduced when students left the terminal without properly signing-off with the light pen device. If it could be assumed that the three treatment groups contributed equally to this source of error, then one could reasonably attribute a substantial cost savings to the Remedial Prescription - Forced Mastery group.

Treatment mean differences on the Attitude Toward Health Education and Attitude Toward Computer Managed Instruction questionnaires were not significantly different. The data provided by both of these instruments failed to indicate any differential effects associated with the treatment groups employed. With respect to the former instrument, it should be noted that the mean Attitude Toward Health Education scores were practically the same for the CMI and CI groups. These data suggest that the method of instruction which characterized the CMI presentation was as effective in conveying positive attitudes and values as was the traditional method of instruction characterized by a greater degree of student-professor contact. Consern by professional health educators, as well as many other teachers, is as much for the development of positive attitudes toward a body of content as for acquisition of specific knowledge. Technology is often viewed as a means of conveying information but as potentially detrimental to the development of positive attitudes. However, the results of this study would not tend to support this contention.

Perhaps more informative than the results on these two measures were the ancedotal comments of an attitudenal nature made by CMI students throughout the course. Two of these types of comments deserve mention at this point. The first of these relates specifically to the Forced Mastery group. Many of the students in this group felt the requirement of repeating failed module posttests was more punitive than helpful. In an experimental treatment period of such duration it was inevitable that many students became aware of the alternate procedures delineating the treatment conditions. Many of those in the Remedial Prescription - Forced Mastery group simply felt that their treatment group assignment was an unfortunate one.

The second class of ancedotal remarks was common to all the CMI groups. Many students expressed the opinion that course requirements were far in excess of their expectations. This point deserves closer examination. The total reported study time means ranged from approximately 35 to 38 hours. These figures represent slightly more than an hour of study time per objective or slightly less than four hours of study time per week for a three credit-hour course. Thus, the most plausible interpretation of such remarks seems to be that while the actual work load was not in excess of most university standards, the students had anticipated something less on the basis of the course requirements in preceeding quarters.

These ancedotal remarks regarding perceived exorbitant student requirements are reflected in responses to two items of the Information Questionnaire. The CMI students' expectancy in terms of course grade (Item 1, Table 29) showed a disproportionate downward shift from the pre- to post administrations when compared to the CI group. Similarly results of Item 3 (Table 31) concerning the students' level of motivation to do well in the course also showed this disproportionate shift from the first to second administration. Additional data provided by the Information Questionnaire would indicate that (a) about as many students were satisfied with the CMI experience as were dissatisfied (see Tables 32 and 35);

(b) the vast majority of students felt that they learned what was expected as indicated by the objectives (see Table 33); and c) that the majority of students felt that the course material was at least as relevant to their professional goals as other courses in their curricula (see Table 34).

Of interest also, were the responses to Items 8, 9, and 10 of the Information Questionnaire (see Table 36) concerning the frequency and types of student interaction. Though the mean frequencies may not be the most representative statistic, given the amount of skew indicated by the standard deviations, it is interesting to note the following points: (a) the CI group had the highest mean number of reported interactions with the professor; (b) the Remedial Prescription - Forced Mastery group the highest with the graduate assistants; and (c) the Remedial Prescription - Forced Progression the highest (slightly greater than Forced Progression) with fellow students. These points may be interpreted as follows: (1) the fact that the Remedial Prescription - Forced Mastery group appeared to have more interaction with the graduate assistants is consistent with the first class of ancedotal remarks cited previously, i.e., many of these interactions were questions regarding the forced criterion requirement; (2) the CI group had the greatest liklihood of interaction with the professor in that they attended his class three times per week; and (3) students in the Remedial Prescription -Forced Progression and Forced Progression groups appeared to resolve their class-related problems with fellow students.

One additional observation related to the interaction between CMI students and the professor should be noted. This observation relates specifically to the optional help-discussion sessions offered weekly by the professor. The purpose of these sessions was to provide the opportunity for student-professor interaction in anticipation of the student's questions regarding course content or other concerns. The attendance at these optional sessions was extremely low (about 5 students per week) at the beginning of the quarter and finally diminished to the point that they were discontinued. Thus, it appeared that these anticipated student needs were (a) not present, or (b) satisfied by alternate means, presumably by interacting with the graduate assistants or fellow students.

The results of the Student Strategy Questionnaire, though its use was primarily exploratory, indicate a potentially promising area for future research. The data presented for Forms A and B of this instrument strongly suggest that the strategies which students employ in meeting course requirements are influenced by the course content and/or the instructional method.

Further, there was limited evidence to suggest that different student strategy "types" performed differentially on the final examination. If such a questionnaire were to be expanded and refined, it could prove to be of value in aptitude by treatment (ATI) interaction studies. This expanded questionnaire might include the following: a) a study-time dimension, i.e., students who complete requirements at a uniform rate as opposed to those who tend to procrastinate; b) a value dimension; i.e., a measure of the student's perception of the value of the course content to his personal or professional aspirations; c) student "expectency," including a measure of the significance that course grades possess for him, which is related to d) a need-achievement dimension.

Such an instrument could be potentially valuable in ATI studies in that it may be possible to (a) induce an optimal strategy for an instructional method; or (b) to select the optimal instructional method for students of a particular strategy classification.

In conclusion, the methodology and results of the present investigation suggests the need for further exploration in two additional, separate but related areas. The first of these recommended areas of research relates to optimizing the revision strategy.

In the present study, module posttest performance as well as final examination performance fell considerably below the criterion level of 80%. In addition, the obtained correlations between study time, confidence, and module posttest scores suggest that those students who spent more time studying were more confident in their knowledge of the subject matter, yet the relationship between time spent studying per module and the module score was minimal. Given these facts, how does one most effectively and efficiently revise the course to insure criterion performance?

The second recommended area for additional research deals with CAI remediation and reviews and may provide a partial solution to the foregoing question. This suggested area deals with the efficacy of providing on-line instruction within the CMI framework. This instruction might take the form of on-line remedial exercises (e.g., linear or branching programs presented via CAI) or it could be presented in the form of

More specifically, research is needed to determine the most effective means of designing and integrating on-line instruction for inclusion in a CMI paradigm.

It is conceivable that the addition of such on-line instruction would: (a) augment the immediate effects of frequent testing; and (b) reduce the retention loss between the time of acquisition and the time of criterion assessment.

CHAPTER VI

SUMMARY

This study investigated the differential effects of selected instructional strategies in a computer-managed instruction (CMI) learning environment. The investigatory questions were primarily concerned with treatment group comparisons on measures of performance, attitude, and time. Questionnaires and other self-report measures were used to characterize student strategies.

The sample consisted of 167 undergraduates in a health education course at Florida State University. Forty-one of these students received traditional classroom instruction (CI group) and served as a control group. The remaining students were randomly assigned to one of three CMI treatments. For these latter students, the course was divided into 14 modules with a total of 32 objectives. Throughout the course, module posttests were administered which consisted of 5 items per objective which were randomly selected from a pool of 15 items. The criterion for passing a module test was set at 80%.

During the first week of classes the pretest and other evaluative instruments were administered to all students. For the remainder of the quarter, the CMI students proceeded with their study of appropriate self-instructional materials. When a student felt prepared to be tested, he scheduled computer time and was administered the posttest on the module he had completed. Upon course completion, the evaluative instruments and final examination were administered to all students. The final examination was composed of 4 items for each course objective. Half of these items were used in the module posttests, the other half were used only on the pretest and final examination.

One of the CMI treatment groups, Remedial Prescription-Forced Mastery, represented the most typical CMI strategy. If students in this group failed to reach criterion on an objective, they were presented remedial prescriptions and were required to take another randomly chosen set of items until they reached criterion.

Students in the Remedial Prescription-Forced Progression group who failed to reach criterion on an objective were only presented the remedial prescriptions and were not permitted to repeat the failed posttest.

In the Forced Progression group, students who failed to reach criterion on an objective were given neither remedial prescriptions nor were they permitted to repeat the failed posttest.

The results demonstrated a general superiority of the CMI groups over the CI groups on final examination performance. This superiority was attributed to (a) a greater degree of familiarity with the objectives and criteria for the CMI groups; (b) differential content emphasis; (c) the positive effects of frequent testing; (d) the composition of the final examination; and (e) possible differences in levels of achievement motivation on the final examination.

The results of performance and attitude measures failed to demonstrate the efficacy of requiring forced mastery only or of providing remedial prescriptions only. However, the group required to reach mastery, which was also given remedial prescriptions, had significantly greater mean final examination scores than the group which was not required to reach mastery nor given prescriptions. These data supported the interpretation that with this initial field test of the course, the effects of content organization, presentation format, and frequent testing overshadowed the more subtle effects associated with the differential CMI treatment characteristics.

Comparisons of time indices among the CMI groups indicated no significant differences in study time or in the number of days required to complete half or all of the module posttests. Limited evidence suggested that the Remedial Prescription-Forced Progression group required significantly less computer time. Average time on the computer for all CMI students was approximately 3.5 hours, while CI students spent 30 hours in the classroom.

Finally, self-report measures and ancedotal remarks suggested that: (a) some students disliked the forced mastery requirement; (b) student "studying" strategies were influenced by the course content and instructional method; and (c) students of different strategy "types" performed differentially on the final examination.

APPENDICES

APPENDIX A

LIST OF FOURTEEN MODULES WITH THE NUMBER OF OBJECTIVES IN EACH

APPENDIX A

LIST OF FOURTEEN MODULES WITH THE NUMBER OF OBJECTIVES IN EACH

Module	No. of Objectives in Module
Consumer Health	2
Communicable Diseases	3
Nutrition	3
Mood Modifiers	2
Special Topics	2
Dental Health	2
Vision	3
School Health	3
Healthful Environment	3
Mental Health	2
Sex Education	3
First Aid	1
Hearing	2
Growth	1

APPENDIX B

CONFIDENCE ASSESSMENT SCALE

APPENDIX B

CONFIDENCE ASSESSMENT SCALE

Which of the following statements best describes your knowledge of the content included in this module?

▨ I am very poorly prepared

▨ I know a little about some of the objectives

▨ I know something about all of the objectives

▨ I have a pretty good knowledge of all of the objectives

▨ I am very well prepared

APPENDIX C

ASSESSMENT OF TIME SPENT ON EACH MODULE

APPENDIX C

ASSESSMENT OF TIME SPENT ON EACH MODULE

Approximately how much time did you spend studying for this module?
Please answer honestly, your response will not affect your grade.

▨ None

▨ About 1 hour

▨ About 2 hours

▨ About 3 hours

▨ More than 3 hours

APPENDIX D

STUDENT STRATEGY QUESTIONNAIRE (FORM A)

APPENDIX D

STUDENT STRATEGY QUESTIONNAIRE (FORM A)

Students vary considerably in the "strategies" they employ in meeting course requirements or assignments. Of course, many students use different strategies for different types of courses, i.e., one might not study chemistry in the same manner as history.

This questionnaire describes 5 common strategies and asks you to rate yourself on each strategy as to how typical it is of your general strategy. Please read each carefully and respond honestly by circling the number of your choice on each scale. Your response has no bearing on your course evaluation.

Strategy 1: I usually put off all studying and/or course work as long as possible. I seem to work more efficiently when the "pressure is on" to meet an upcoming deadline. I usually procrastinate.

not at all typical 1 2 3 4 5 6 7 8 9 very typical

Strategy 2: I usually complete my course work at a steady, consistent rate. I feel a committment to work steadily week after week so that I won't ever get behind.

not at all typical 1 2 3 4 5 6 7 8 9 very typical

Strategy 3: I usually study or spend my time on only those course topics which are of interest to me. I don't usually study that material which doesn't interest me.

not at all typical 1 2 3 4 5 6 7 8 9 very typical

Strategy 4: I usually study or spend my time on only those topics that I don't know. If I'm satisfied with my knowledge of an area, I let it go; if I'm unsatisfied, I study it well.

not at all typical 1 2 3 4 5 6 7 8 9 very typical

Strategy 5: I usually study everything that is recommended by the course instructor. I will typically read all the assigned material for a course, and often read further in order to really understand the subject.

not at all typical 1 2 3 4 5 6 7 8 9 very typical

My usual strategy is most like Strategy Number (circle one):

1 2 3 4 5

APPENDIX E

STUDENT STRATEGY QUESTIONNAIRE (FORM B)

APPENDIX E

STUDENT STRATEGY QUESTIONNAIRE (FORM B)

At the beginning of the course, you were asked to respond to a questionnaire about your typical strategy in meeting course requirements. This questionnaire is very similiar, however, you are now asked to rate yourself on each of the 5 strategies shown below, as to how they describe the strategy you used in this course. Read each carefully and respond honestly by circling the number of your choice on each scale. Your responses have no bearing on your course evaluation.

Strategy 1: I usually put off all studying and/or course work as long as possible. I seemed to work more efficiency when the "pressure was on" to meet an upcoming deadline. I usually procrastinated.

not at all typical 1 2 3 4 5 6 7 8 9 very typical

Strategy 2: I usually completed my course work at a steady, consistent rate. I felt a committment to work steadily week after week so that I never got behind.

not at all typical 1 2 3 4 5 6 7 8 9 very typical

Strategy 3: I usually studied or spent my time on only those course topics which were of interest to me. I didn't usually study that material which didn't interest me.

not at all typical 1 2 3 4 5 6 7 8 9 very typical

Strategy 4: I usually studied and spent my time on only those topics that I didn't know. If I was satisfied with my knowledge of a module, I let it go; if I was unsatisfied, I studied it well.

not at all typical 1 2 3 4 5 6 7 8 9 very typical

Strategy 5: I usually studied everything that was recommended. I read all the primary references and often read the secondary and alternative references in order to really understand the subject.

not at all typical 1 2 3 4 5 6 7 8 9 very typical

My strategy in this course was most like Strategy Number (circle one):

1 2 3 4 5

APPENDIX F

STUDENT ATTITUDE TOWARD COMPUTER MANAGED INSTRUCTION

APPENDIX F

STUDENT ATTITUDE TOWARD COMPUTER-MANAGED INSTRUCTION

Developed by Bobby R. Brown

This is not a test of information; therefore, there is no one "right" answer to a question. We are interested in your opinion on each of the statements below. Your opinions will be strictly confidential. Do not hesitate to put down exactly how you feel about each item. We are seeking information, not compliments; please be frank.

Name:______________________________ Date____________________

Name of Course:______________________________ Student Number__________

CIRCLE THE RESPONSE THAT MOST NEARLY REPRESENTS YOUR REACTION TO EACH OF THE STATEMENTS BELOW:

1. While taking Computer-Managed Instruction I felt challenged to do my best work.

   Strongly Disagree   Disagree   Uncertain   Agree   Strongly Agree

2. The material presented to me by Computer-Managed Instruction caused me to feel that no one really cared whether I learned or not.

   Strongly Disagree   Disagree   Uncertain   Agree   Strongly Agree

3. The method by which I was told whether I had given a right or wrong answer became monotonous.

   Strongly Disagree   Disagree   Uncertain   Agree   Strongly Agree

4. I was concerned that I might not be understanding the material.

   Strongly Disagree   Disagree   Uncertain   Agree   Strongly Agree

5. I was not concerned when I missed a question because no one was watching me anyway.

   Strongly Disagree   Disagree   Uncertain   Agree   Strongly Agree

6. While taking Computer-Managed Instruction I felt isolated and alone.

All the time	Most of the time	Some of the time	Only occasionally	Never

7. While taking Computer-Managed Instruction I felt as if someone were engaged in conversation with me.

All the time	Most of the time	Some of the time	Only occasionally	Never

8. The responses to my answers seemed appropriate.

All the time	Most of the time	Some of the time	Only occasionally	Never

9. I felt uncertain as to my performance in the programmed course relative to the performance of others.

All the time	Most of the time	Some of the time	Only occasionally	Never

10. I found myself just trying to get through the material rather than trying to learn.

All the time	Most of the time	Some of the time	Only occasionally	Never

11. I knew whether my answers were correct or not before I was told.

Quite often	Often	Occasionally	Seldon	Very Seldom

12. I guessed at the answers to questions.

Quite often	Often	Occasionally	Seldom	Very Seldom

13. In a situation where I am trying to learn something, it is important to me to know where I stand relative to others.

Strongly Disagree	Disagree	Uncertain	Agree	Strongly Agree

14. I was encouraged by the responses given to my answers of questions.

Strongly Disagree	Disagree	Uncertain	Agree	Strongly Agree

15. As a result of having studied some material by Computer-Managed Instruction, I am interested in trying to find out more about the subject matter.

Strongly Disagree | Disagree | Uncertain | Agree | Strongly Agree

16. In view of the time allowed for learning, I felt too much material was presented.

All the time | Most of the time | Some of the time | Only occasionally | Never

17. I was more involved in running the machine than in understanding the material.

All the time | Most of the time | Some of the time | Only occasionally | Never

18. I felt I could work at my own pace with Computer-Managed Instruction.

Strongly Disagree | Disagree | Uncertain | Agree | Strongly Agree

19. Computer-Managed Instruction makes the learning too mechanical.

Strongly Disagree | Disagree | Uncertain | Agree | Strongly Agree

20. I felt as if I had a private tutor while on Computer-Managed Instruction.

Strongly Disagree | Disagree | Uncertain | Agree | Strongly Agree

21. I was aware of efforts to suit the material specifically to me.

Strongly Disagree | Disagree | Uncertain | Agree | Strongly Agree

22. I found it difficult to concentrate on the course material because of the hardware.

All the time | Most of the time | Some of the time | Only occasionally | Never

23. The Computer-Managed Instruction situation made me feel quite tense.

Strongly Disagree | Disagree | Uncertain | Agree | Strongly Agree

24. Questions were asked which I felt were not relevant to the material presented.

All the time	Most of the time	Some of the time	Only occasionally	Never

25. Computer-Managed Instruction is an inefficient use of the student's time.

Strongly Disagree	Disagree	Uncertain	Agree	Strongly Agree

26. I put answers in knowing they were wrong in order to get information from the machine.

Quite often	Often	Occasionally	Seldom	Very Seldom

27. Concerning the course material I took by Computer-Managed Instruction, my feeling toward the material before I came to Computer-Managed Instruction was:

Very favorable	Favorable	Indifferent	Unfavorable	Very unfavorable

28. Concerning the course material I took by Computer-Managed Instruction, my feeling toward the material after I came to Computer-Managed Instruction is:

Very favorable	Favorable	Indifferent	Unfavorable	Very unfavorable

29. I was given answers but still did not understand the questions.

Very often	Often	Occasionally	Seldom	Very seldom

30. While on Computer-Managed Instruction I encountered mechanical malfunctions.

Very often	Often	Occasionally	Seldom	Very Seldom

31. Computer- Managed Instruction made it possible for me to learn quickly.

Strongly Disagree	Disagree	Uncertain	Agree	Strongly Agree

32. I felt frustrated by the Computer-Managed Instruction situation.

Strongly Disagree   Disagree   Uncertain   Agree   Strongly Agree

33. The responses to my answers seemed to take into account the difficulty of the question.

Strongly Disagree   Disagree   Uncertain   Agree   Strongly Agree

34. I could have learned more if I hadn't felt pushed.

Strongly Disagree   Disagree   Uncertain   Agree   Strongly Agree

35. The Computer-Managed Instruction approach is inflexible.

Strongly Disagree   Disagree   Uncertain   Agree   Strongly Agree

36. Even otherwise interesting material would be boring when presented by Computer-Managed Instruction.

Strongly Disagree   Disagree   Uncertain   Agree   Strongly Agree

37. In view of the effort I put into it, I was satisfied with what I learned while taking Computer-Managed Instruction.

Strongly Disagree   Disagree   Uncertain   Agree   Strongly Agree

38. In view of the amount I learned, I would say Computer-Managed Instructon is superior to traditional instruction.

Strongly Disagree   Disagree   Uncertain   Agree   Strongly Agree

39. With a course such as I took by Computer-Managed Instruction, I would prefer Computer-Managed Instruction to traditional instruction.

Strongly Disagree   Disagree   Uncertain   Agree   Strongly Agree

40. I am not in favor of Computer-Managed Instruction because it is just another step toward de-personalized instruction.

Strongly Disagree   Disagree   Uncertain   Agree   Strongly Agree

APPENDIX G

ATTITUDE TOWARD HEALTH EDUCATION

APPENDIX G

ATTITUDE TOWARD HEALTH EDUCATION

Directions: Please respond to each of the following statements by marking your machine-scorable answer sheets according to the following code:

1 - strongly agree	4 - disagree
2 - agree	5 - strongly disagree
3 - uncertain	

---

1. Health education is of great value.
2. I really enjoy health education.
3. Health education is profitable to everyone who takes it.
4. Health education is very practical
5. Health education is a universal subject
6. I could do very well without Health Education
7. I am not interested in health education.
8. I see no value in health education.
9. Health education is based on "fogy" ideas.
10. Health education is a waste of time.
11. The very existence of humanity depends on health education.
12. If I had my way, I would compel everybody to take health education.
13. Health education gives students knowledge to help interpret problems that they will meet in life.
14. Health education serves the needs of many people.
15. Health education seems to be a necessary evil.
16. Health education cannot benefit me.
17. Health education is more a plague than a study.

APPENDIX H

INFORMATION QUESTIONNAIRE

APPENDIX 4

INFORMATION QUESTIONNAIRE

Please be straight forward in your appraisal of your attitudes toward this class. The material will not be analysed prior to turning in grades. Read and answer every one of the questions, please. Your responses will assist in the revision and evaluation of the course.

Circle the number to the left of your choice, as:

Do you like rain?
1. Yes, very much
[✓ 2. Sometimes]
3. Not at all

1. What grade do you expect to receive in this course?________

2. What is your attitude toward your grade for this course at this time in the quarter?

3. At this point in the course, how would you rate your level of motivation to do well in the course?
    1. Very highly motivated
    2. Somewhat motivated
    3. Only slightly motivated
    4. Not at all motivated

4. Would you take another course by Computer-Managed Instruction?
    1. Gladly
    2. Possibly
    3. Reluctantly
    4. Never

5. Did you feel you learned what was expected of you as indicated by the objectives?
    1. Yes
    2. Don't know
    3. No

6. Do you feel the material in this course is relevant to your professional goals?
    1. More relevant than other courses
    2. As relevant as other courses
    3. Less relevant
    4. Not at all relevant to my goals

7. Would you have preferred "text and lecture" classes?
    1. Absolutely, for this course
    2. Maybe
    3. Not at all, for this course

8. Approximately how many times to date have you interacted with the professor in the course

____

9. Approximately how many times to date did you interact with the graduate assistants in this course?

____

10. Approximately how often to date have you asked fellow students for help or to discuss problems?

____

APPENDIX I

TABLE OF POWER VALUES FOR STATISTICAL TESTS

APPENDIX I

Table of power values (x100) for three conventional effect size levels for the statistical tests presented in the respective tables of Chapter IV

				EFFECT SIZE*	
TABLE	STATISTIC	SOURCE	SMALL	MEDIUM	LARGE
6,7	F	A	16	76	99
6,7	F	B	14	61	95
6,7	F	AB	16	76	99
8	z	RPFM	08	44	90
8	z	RPFP	09	48	92
8	z	FP	08	40	86
8	z	CI	08	44	90
10	F	TREATMENTS	16	76	99
12	F	TREATMENTS	32	73	99
15	F	TREATMENTS	16	77	99
17	F	A	16	73	99
17	F	B	15	65	96
17	F	AB	16	73	99
18,20,22	r		20	93	99
24	F	TREATMENTS	16	73	99
25,26,28	r		20	93	99
29,30,31	X^2		47	81	99
32,35	X^2		47	80	99
38a	X^2		58	88	99
38b	X^2		23	42	72

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*The effect size indices for the respective statistics and the conventional definitions of small, medium, and large are those suggested by Cohen (1969). All power values are for $\alpha = .05$.

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VITA

Name: R. Michael Lawler

Date of Birth: December 14, 1945

Marital Status: Married, 1 child

Social Security No.: 267-76-1636

Business Address:
Computer-Assisted Instruction Center
1-A Tully Building, Florida State University
Tallahassee, Florida 32306
Phone: 904--599-3660

Educational Background

Ph.D.	Department of Educational Research, Florida State University, March, 1971
M.S.	Counselor Education, Florida State University, 1968
B.S.	Natural Science, University of Tennessee, 1967

Positions Held

6/70-Present	Research Assistant, Department of Biological Sciences, Florida State University. Presently involved with the design and implementation of a Preclinical Basic Medical Sciences Program at Florida State University. Also involved in the design of educational programs for the Comprehensive Health Planning program encompassing an eight-county area of North Florida. The doctoral dissertation is concerned with instructional strategies in a Computer-Managed Instruction Course in Health Education.

R. Michael Lawler--Vita

9/68-6/70	U.S. Office of Education Fellow in Computer-Assisted Instruction, Florida State University. Research and academic experience related to problems in the general area of instructional technology and psychology. Coursework covered such topics as traditional learning theory, mathematical learning theory, statistics and research design, test theory, models for designing instruction, instructional simulation, and individual learner characteristics.
6/68-9/68	State Department of Education, Division of Vocational Rehabilitation, Tallahassee, Florida. Designed and directed an occupational information survey for the Tallahassee District, Division of Vocational Rehabilitation.

Professional Affiliations:

American Educational Research Association

Major Research Interests:

Concerned with the design, implementation, and evaluation of instructional systems, especially within the context of medical education. Special interests include the use of the computer in research, instruction, and the simulation of medical diagnosis.

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